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MEMOIR No. 36

NATAL TOWN AND REGIONAL PLANNING REPORTS
VOLUME 10

A PLANT ECOLOGY SURVEY

OF THE

TUGELA RIVER BASIN, NATAL

BY

DENZIL EDWARDS

DEPARTMENT OF AGRICULTURAL TECHNICAL SERVICES
BOTANICAL RESEARCH INSTITUTE
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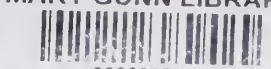
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FRONTISPIECE, *Protea* Savanna in foothills of High Drakensberg. Royal Natal National Park.

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"What now remains compared with what then existed is like the skeleton of a sick man, all the fat and soft earth having wasted away, and only the bare framework of the land being left. But at that epoch the country was unimpaired, and for its mountains it had high arable hills, and in the place of the moorlands, as they are now called, it contained plains full of rich soil; and it had much forest-land in its mountains, of which there are visible signs even to this day."

Plato (427—347 B.C.) *Critias*

Thesis approved for the degree of Doctor of Philosophy at the University of Natal

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FOREWORD

By Dr. G. C. SCULLY, Chairman, Natal
Town and Regional Planning Commission.

The Tugela Basin Plant Ecology Research Fellowship was established by the Town and Regional Planning Commission in November, 1953. This was the second research fellowship sponsored by the Commission.

Two major reasons impelled the Commission to establish plant ecology research in the province. The first was the immediate need to evaluate, within close limits, the natural physical resources of the Tugela Basin, and the factors which would have significance in their exploitation. Clearly the state of the land and water resources, as the basic elements in agricultural and pastoral production, is a pre-eminent consideration. Land management practices not only form a guide to the long-term reliance which can be placed on the continued productive capacity of the land, but also determine whether river flow will be reliable and suitable for domestic, agricultural or industrial use. An abnormally high incidence of soil erosion is inimical to the economic construction of water storage schemes, the development of hydro-electric generating plants, and the establishment of industrial undertakings, conditions for which are otherwise extremely advantageous in the region.

The second reason was the necessity of determining whether there were areas of agriculturally productive land which should be retained for food production. Where a greatly increasing human population is likely to be established in a planned and balanced development scheme it is inevitable that more animals will have to be carried and optimum yields obtained, and maintained, from a reduced land area.

When the plant ecology research was commenced, few laymen appreciated the close connection between a progressive or a retrograde plant succession and the planning functions entrusted to the Commission by Ordinance No. 27 of 1949. It is hoped that this foreword will make this connection clear.

Professor A. W. Bayer, Department of Botany, University of Natal and Dr. A. J. Pentz of the Department of Agricultural Technical Services emphasised the value of vegetation studies as an indicator of the resultant life-supporting capacity of climate, soil conditions, aspect, altitude, slope, shelter, fire, and biotic factors. By means of such studies the plant ecologist is able to draw attention to areas where denudation or degenerate vegetal cover indicates the onset of conditions leading to soil erosion. He can ascertain whether current agricultural or pastoral practices are conducive to the achieve-

By Dr. L. E. CODD
Chief, Botanical Research Institute and Director of Botanical Survey, Department of Agricultural Technical Services.

The present publication by Dr. D. Edwards, setting out his report on the vegetation and climate of the Tugela River catchment, represents an important step forward in the programme envisaged some years ago by the Natal Town and Regional Planning Commission. The Commission is to be congratulated on the thorough approach to the problem of assessing the regional resources and natural environment of the Province.

Assets in the form of water and mineral resources must lead to industrial and urban development, which will automatically have their impact on agricultural policy, resulting in the need for intensified land use. The extent to which such a policy can be carried out depends largely on the preservation of the soil which, in turn, frequently calls for efficient maintenance of an intact vegetation cover.

The provision of funds by the Commission for a Plant Ecology Research Fellowship in 1953 made it possible for a detailed survey of the vegetation to be undertaken. Combined as it is with an equally detailed study of the soils, also sponsored by the Commission, the planning of the survey might well serve as a pattern for future investigations of this kind.

It is appropriate that Natal should take a lead in applying a broadly ecological approach to regional planning. The pioneer work by Drs. Scott and Pentz in northern Natal has stressed the basic value of a vegetation survey and its bearing on agricultural use of land in the widest sense. Their creed that a farming system must be in accord with the limits imposed by climate, soils, natural vegetation and topography has received wide acceptance. Deviation beyond these limits, it has often been pointed out, has led to failure of farming ventures and serious, often irreparable, damage to the vegetation and soil. Also, Prof. A. W. Bayer of Natal University, and a member of the steering committee, has long advocated the value of ecology in basic planning. For many years his department has been one of the leading centres for training in ecological research, and students who have passed through his hands are already occupying responsible positions in this country.

Dr. Edwards has shown ability in classifying plant communities into the wider concept of vegetation types, which are associated with, and largely determined by soil, climatic and topographical features. In this way, a picture of the natural environment is built up. The

ment of a vegetation climax-potential or retrogression to degenerate vegetation types and eventual denudation. In association with the hydrologist he is able to forecast with some accuracy what percentage retention of water precipitation on the land will seep into the ground, where it is of the greatest value.

Here then existed a useful tool, characterised by an eminent planning authority in the United Kingdom as a most original and instructive planning development which he commended to all planners and land commissioners. Nevertheless, the compilation of a plant ecology map and report is but a first step toward an ultimate objective. Its eventual aim is to assist in the determining of correct farming systems in each agro-ecological sub-region and the best methods of veld management, soil- and water-conservation. The plant ecologist's findings have to be related to the pedologist's report on the soils and to the geographer's land-use maps. In the Tugela Basin the Commission has secured the services of an eminent ecologist to study the practical implications for planning of these closely allied sciences, a report on which will be published in due course, together with maps showing land capability assessments.

Until December, 1956, plant ecological studies in Natal were mainly confined to the Commission's activities, but the Division of Botany then appointed an officer of its staff to conduct a botanical survey of the Umgeni River catchment. On 1st August, 1960, the Division appointed the research fellow for the Tugela Basin Plant Ecology research to its own staff, thus releasing the Commission from responsibility for the provision of his salary. The Commission welcomed this step and both the Commission and the Botanical Research Institute (which is the present designation for the former Division of Botany), are appreciative of the opportunity which has occurred for mutual co-operation in this most important field for essential research. Plant Ecology research continues in a region of some 4,000 square miles lying immediately south of the Tugela Basin under the auspices of the Botanical Research Institute, supported in every possible manner by the Commission, the Department of Botany and the Agricultural Faculty, University of Natal.

The Commission has pleasure in recording its indebtedness to the Botanical Research Institute and in making this volume by Dr. Denzil Edwards available to the general public. It takes this opportunity of congratulating the author on the successful completion of a valuable and detailed research project.

G. C. Scully, *Chairman*,

Town and Regional Planning Commission.

accompanying maps, on the scale of 1/250,000, were produced largely with the aid of aerial photographs, a technique which has been relatively little used in South Africa, but is obviously worthy of closer study. The work involved in gathering the data and preparing the maps in such detail will, perhaps, be more readily appreciated when it is realised that the area covered is approximately the size of Wales. An earlier survey of a similar nature, covering a smaller area, was undertaken by D. M. Comins, who dealt with the vegetation of the Border Region (the districts of East London and King Williams Town) on the scale of 1/125,000. This survey also formed part of a combined project dealing with land use in that area, and was published as Memoir No. 33 of this series in 1962.

Both these surveys fit in well with the broad classification of the whole country into "Veld Types" by Acocks, and published as Memoir No. 28 (1953). They represent a refinement of the "Veld Type" map, envisaged by the Botanical Research Institute as one of the phases to be undertaken in the general botanical survey programme. Dr. Edwards joined the staff of the Institute in 1960 and, since completing the survey now presented, he has had the opportunity of visiting a number of institutes concerned with ecology in Europe and the United States. The experience which he has gained should provide an impetus to similar research projects in South Africa.

L. E. CODD

Chief, Botanical Research Institute and Director of Botanical Survey, Department of Agricultural Technical Services.

ACKNOWLEDGEMENTS

This survey of the Tugela Basin would not have been possible without the support and assistance of many people, to whom acknowledgement is made. In particular I should like to express my gratitude to:—the Natal Town and Regional Planning Commission, for sponsoring the Fellowship and for generously extending it beyond its original period; to the Steering Committee of the Natal Town and Regional Planning Commission for assistance, guidance and understanding; to Professor A. W. Bayer, my supervisor, who generously provided facilities in the Botany Department of the University of Natal, and for whose guidance, criticisms and assistance I am extremely grateful; to Dr. R. A. Dyer, former chief of the Botanical Research Institute, and to his successor, Dr. L. E. Codd, who allowed me to continue with the survey after joining the staff of the Institute; to the Department of Agricultural Technical Services for allowing this survey to continue as an official project, and for permission to use the results of the survey for a thesis; to Lieutenant-Colonel G. A. T. Davies, for his enthusiastic encouragement and help in many ways; to Professor J. F. V. Phillips and Professor J. D. Scott for editorial and other guidance; to the National Herbarium, Pretoria, and to Dr. K. D. Gordon-Gray and Mrs. O. M. Hilliard, for their help in identifying and checking the names of some 3,000 specimens collected during the survey; to Mr. W. A. Ford, Mr. B. H. Armitage and other members of the drawing office of the Natal Town and Regional Planning Commission, for the efficient manner in which they undertook the drawings of maps and planimetry; to Dr. D. J. B. Killick, who kindly allowed me to use some of the data obtained during his Cathedral Peak survey; to Dr. J. J. van der Eyk, who kindly contributed Chapter 3 on the soils of the Tugela Basin, and to him and Dr. J. M. de Villiers for help on the soils generally; to Dr. S. C. Seagrief, who suggested the quartile method of rainfall analysis and for his assistance in the field; to Mr. H. C. Taylor for providing forestry data and assistance in the field; to Dr. J. A. Pentz and Messrs. A. Fisher, P. J. Edwards and C. J. Ward for assistance and many helpful discussions; to members of the Geography Department, University of Natal, for their help in various ways; to Mr. J. Vincent for plotting the rainfall quartile data; to Mr. G. Tait, Forester at Qudeni, for his generous hospitality and assistance and to many traders, farmers and magistrates, whose kindness, hospitality and help I have enjoyed; to my assistant, Dumisani Meshack Dhlamini, for his loyal and never-failing cheerful help in every branch of this survey; and finally to my wife, who has helped in checking the manuscripts, and never failed in her encouragement.

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INTRODUCTION

The catchment system of the Tugela River is considered to be an area with considerable economic and industrial potential. The Natal Town and Regional Planning Commission has undertaken a comprehensive study of the region, instituting, as part of its programme, a number of research fellowships at the University of Natal. In order to provide information for agricultural development and other aspects, one project was a study of the plant ecology. Thus, on the 11th November ,1953, the Commission resolved to establish a plant ecology research fellowship and, on the 15th July, 1954, the author was appointed Research Fellow in the Botany Department of the University of Natal, Pietermaritzburg.

The geographical position of the Tugela Basin is shown in Fig. 1, the catchment system covering 11,200 square miles, an area approximately that of Belgium.

GEOGRAPHICAL POSITION OF THE TUGELA BASIN IN THE REPUBLIC OF SOUTH AFRICA

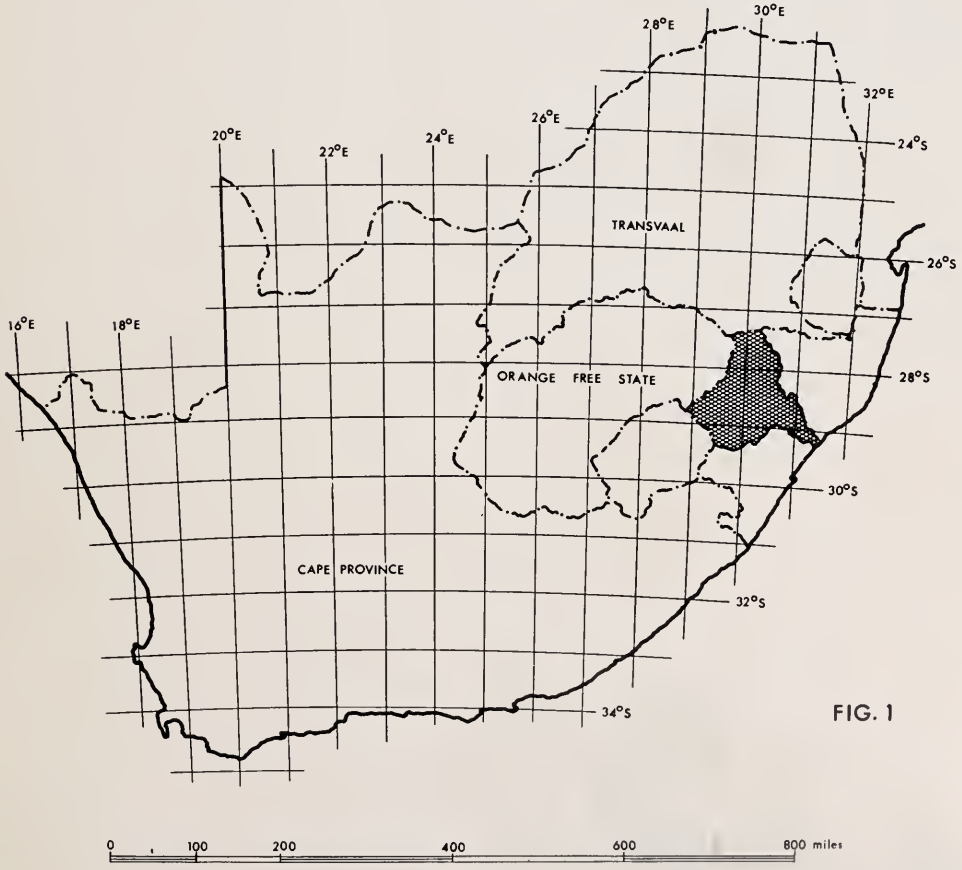


FIG. 1

In considering the approach and general methods to be used for the ecological survey, an important consideration is that there was comparatively little detailed and comprehensive information available. Because of the author's own inexperience and the diversity of vegetation, it was apparent that, to cover the area thoroughly, strict quantitative methods of vegetation analysis could not be extensively employed. The relative importance of species in the vegetation was, therefore, initially estimated on a five-part scale in the well-known method used in early vegetation studies in Europe and other parts of the world. An endeavour has been made to provide an overall and detailed account of climate, biotic factors and vegetation; soils being investigated in a separate survey by a team under Dr. J. J. van der Eyk.

The largest existing scale maps, covering the whole Tugela Basin, were the South Africa 1 : 250,000 Topocadastral Series (1958). This scale and these maps were, therefore, used as base maps for plotting the distribution of the various vegetation types. Sections of the maps were photographically enlarged to a scale of approximately 1 : 100,000 for use in the field, the data being readily transferred back on to the original maps. Air photos, that became available later during the survey, were used to check the plotting of the major vegetation types.

Botanical specimens collected during the survey are lodged in the National Herbarium, Pretoria, and in the Herbarium of the Botany Department, University of Natal, Pietermaritzburg.

The concepts employed in this survey are those of the Anglo-American school of ecology. Emphasis is laid on the dynamic nature of vegetation and of plant succession and development to a climax type of plant community. A polyclimax viewpoint, that physiography, soils, fire and biotic factors may result in vegetation attaining a position of "relative stability" (Tansley, 1939), has been adopted in preference to Clements' (1936) monoclimax concept. Because of their well known and clear definitions, however, Clementsian terms have been used to illustrate the status of various plant communities. The term "climatic climax" has been used to prevent ambiguity. Though the epithet is superfluous from a monoclimax viewpoint (Clements, 1936), the usage is necessary when recognising also other forms of climax. The adoption of a polyclimax viewpoint should not be construed as minimising the importance of the concept of the climatic climax: the division of the Tugela Basin into seven ecological regions or regional ecosystems, each with a specific climatic climax, emphasises the importance of the concept.

From experience gained during this survey, it would not be inappropriate to suggest that a more strictly quantitative and phytosociological approach to vegetation surveys, using concepts such as those employed by Whittaker (1953), Goodall (1954), or Curtis (1959), might provide a clearer understanding of the nature of Natal vegetation. It is hoped that the results of this survey can aid in stimulating scientific understanding, as well as providing some of the practical bases for regional planning, agricultural development and utilization of the land.

CHAPTER 1

PHYSIOGRAPHY

The geological structure of the Tugela Basin consists essentially of younger, predominantly sedimentary, members of the Cape and Karroo systems resting upon a number of ancient, folded, intrusive and intensely metamorphosed formations of the Archaean Basement Complex. The present-day surface distribution of the geological formations is shown in Fig. 2.

The principal contours and river systems of the Basin are shown in Fig. 3.

In this account, the Basin is divided into seven ecological regions (Fig. 4). They are: (*A*) Coast Lowlands, (*B*) Coast Hinterland, (*C*) Valley, (*D*) Interior Basins, (*E*) Midland Mist Belt, (*F*) Highlands, (*G*) Mountain. These regions correspond closely to the physiographic landforms of Fair (1955), who pointed out the close relationship between physiography, climate and vegetation (see also Fig. 5).

(A) COAST LOWLANDS REGION

The Coast Lowlands extend from sea-level to 1,500 ft altitude, forming a narrow region about 15 miles wide in the extreme south-eastern section of the Basin. On the undulating topography of this Region the underlying rocks are seldom exposed except on a few small hills.

(B) COAST HINTERLAND REGION

The Coast Hinterland extends from 1,500 ft to 3,500 ft altitude on both sides of the lower Tugela Valley. The chief geological formations are the Table Mountain Series, Insuzi Series, Archaean Granite, Nkandla Formation and Mfongosi Formation. On the Table Mountain Series, the country has a flat plateau appearance, with spectacular sandstone cliffs making an abrupt transition to the lower lying Valley Region. On the primitive, highly folded, intensely metamorphosed formations of the Insuzi Series and Archaean Basement Complex, the topography may be steeply undulating or rugged and broken.

(C) VALLEY REGION

The wild and rugged Valley Region is one of the major physiographic features of the Tugela Basin. It extends from Mandini, about eight miles from the sea, to Colenso and Ladysmith, over one hundred miles inland. It varies from one to twenty miles in width. Its maximum depth, below Qudeni, is more than 4,000 ft.

The Valley Region can be divided into the Lower Valley Sub-region and the Interior Valley Sub-region. In the Lower Valley Sub-region, from Mandini to the Buffalo-Tugela confluence, the river gradient is fairly gentle and the geological formations are mostly Cape or pre-Cape. The valley sides are steeply sloping.

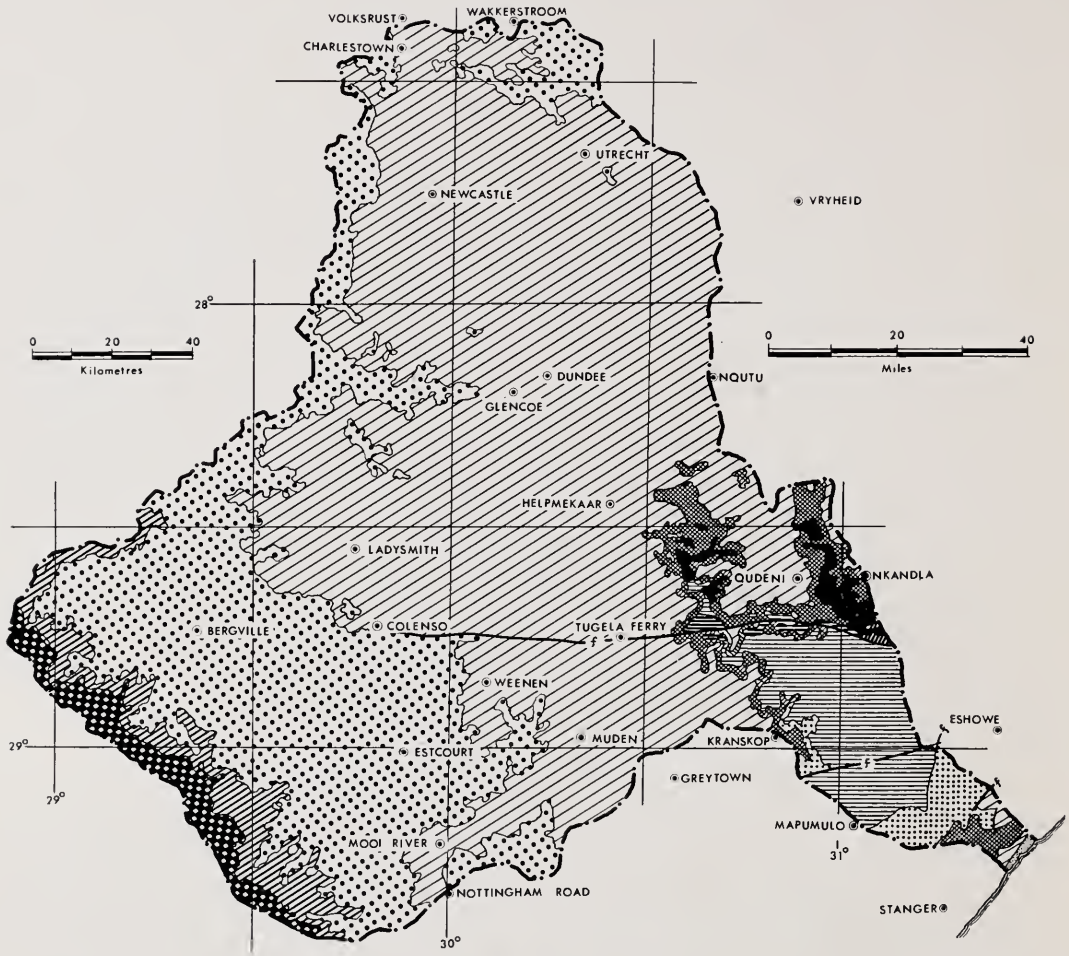
In the Interior Valley Sub-region, which extends inland from the Buffalo-Tugela confluence to Colenso and Ladysmith, the larger tributaries of the Tugela River have produced considerable widening of the Valley. In this Sub-region, numerous dolerite intrusions, capping stony ridges, koppies, and steep valley flanks, contribute to a rough topography and to a markedly stepped gradient of the Tugela River

(D) INTERIOR BASINS REGION

This, the largest of the Regions, is formed by the two large pediplains of the Buffalo and Tugela Rivers, which are separated by the Biggarsberg-Helpmekaar-Msinga Range. The altitude ranges from 3,000 ft to 4,500 ft.

Breaking the general evenness of the Interior Basins Region landscape are numerous dolerite sills and dykes, forming rocky ridges, hills and divides between the various rivers. The dolerite intrusions are common, but are less frequent and massive in the sandy Buffalo River Basin than south of the Biggarsberg, where they produce a more undulating topography. Middle Ecca sandstones are the dominating geological feature of the Interior Buffalo River Basin, whereas south of the Biggarsberg, geological formations are represented almost equally by the Beaufort Series, the Ecca Series and dolerite intrusions.

GEOLOGICAL MAP OF THE TUGELA RIVER BASIN



TERTIARY TO RECENT

KARROO SYSTEM

UPPER STORMBERG SERIES (Basalt, limburgite, pyroclasts, minor sandstone)

LOWER STORMBERG SERIES (Sandstone, shale, mudstone, marl)

BEAUFORT SERIES (Shale, mudstone, sandstone, limestone)

ECCA SERIES (Shale, sandstone, grit, coal)

DWYKA SERIES (Tillite, shale)

CAPE SYSTEM

TABLE MOUNTAIN SERIES (Sandstone, shale)

DOMINION REEF SYSTEM

INSUZI FORMATION (Andesitic lava, acid lava and porphyry, sediments, pyrocasts)

ARCHAEAN COMPLEX

ARCHAEAN GRANITE, INCLUDING ULTRABASIC AND BASIC ROCKS AND THEIR METAMORPHOSED DERIVATIVES. (Several types of granite, granitic gneiss, granulite, undifferentiated granitised Archaean rocks)

NKANDLA FORMATION (Conglomerate, quartzite shale, phyllite, limestone, tillite, basic lava)

MFONGOSI AND NONDWENI FORMATIONS (Basic lava, acid lava and porphyry pyroclasts limestone ironstone)

FAULT

FIG. 2

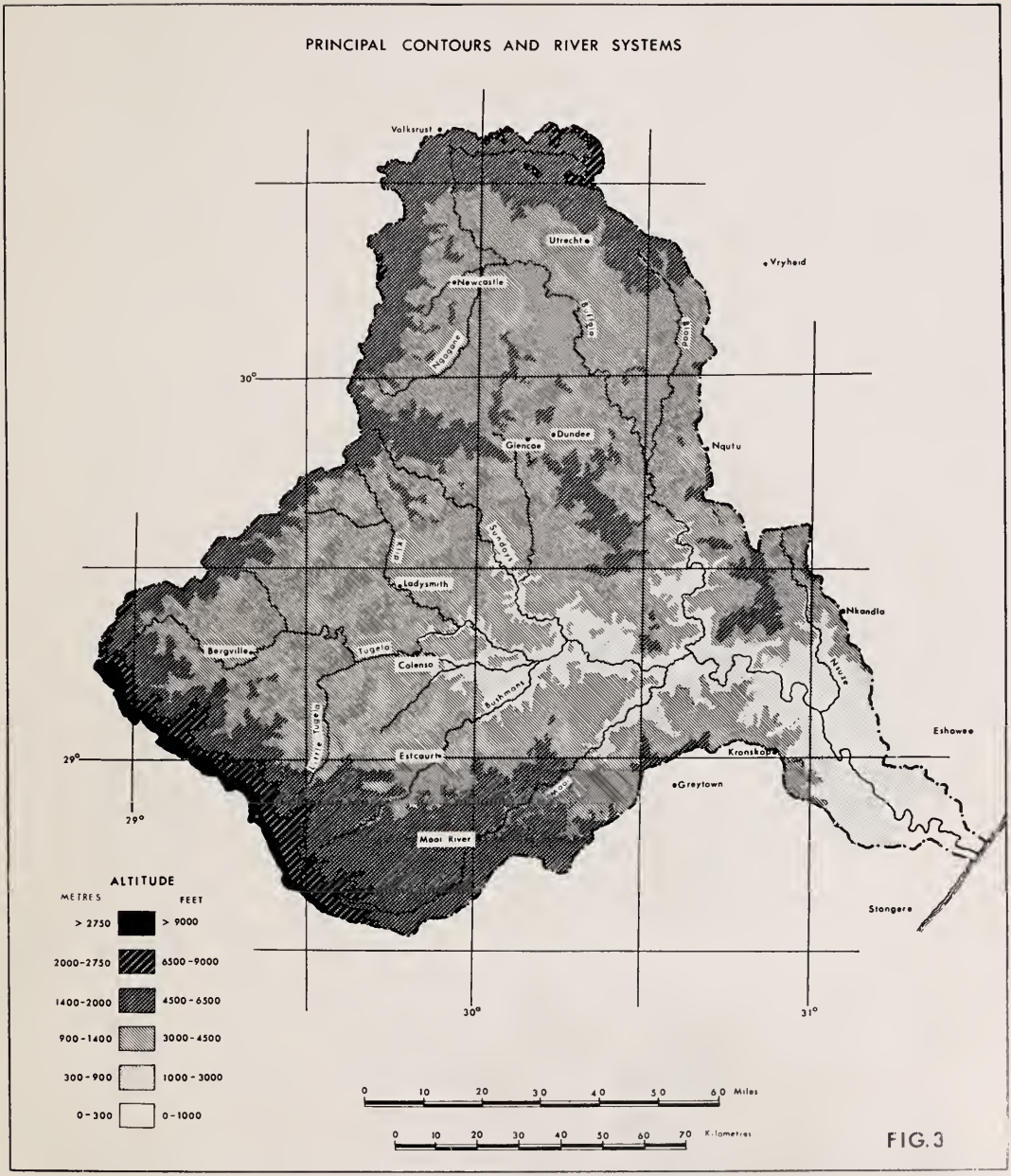
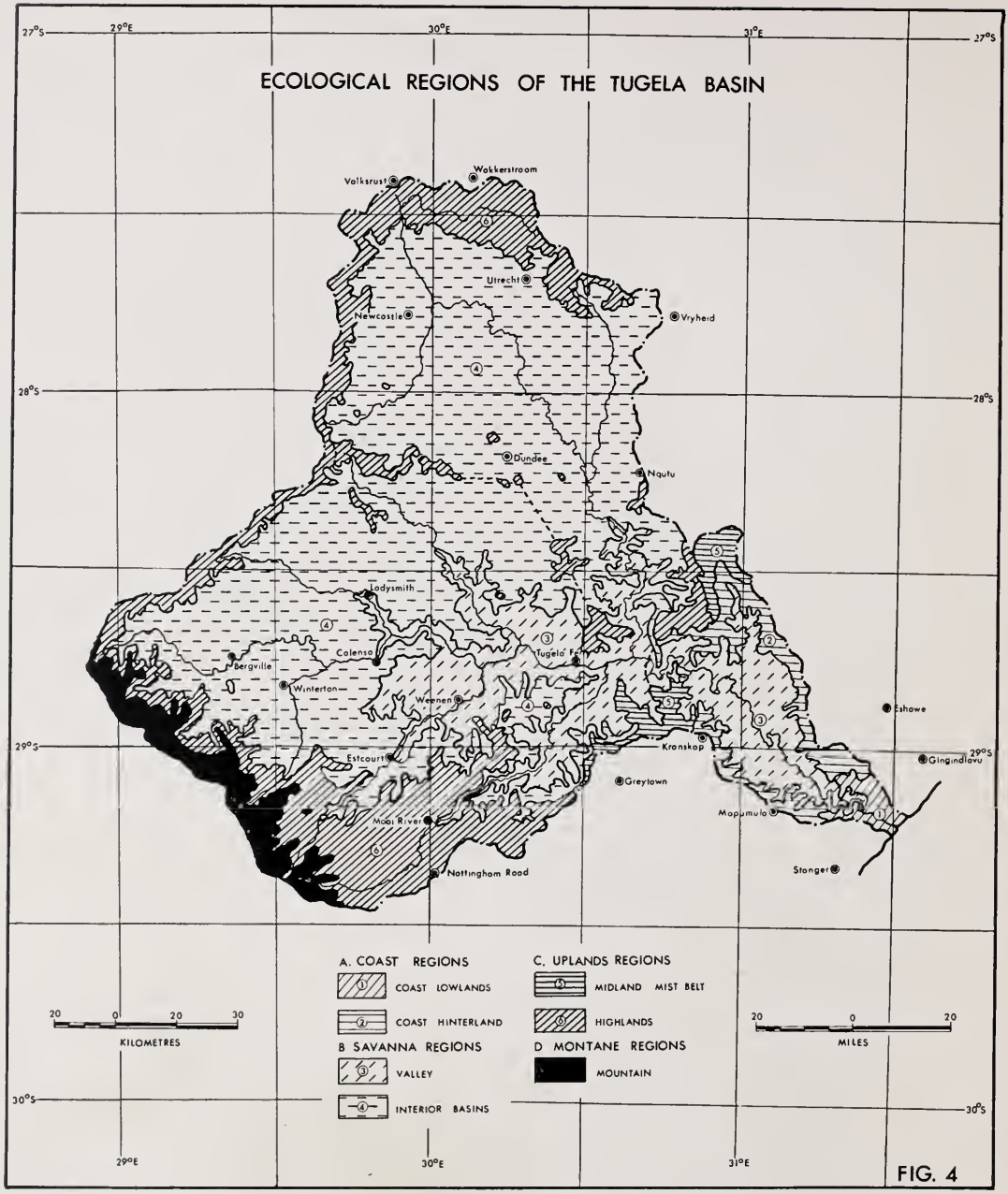

PRINCIPAL CONTOURS AND RIVER SYSTEMS
Volksrust
Utrecht
Vryheid
Newcastle
Ngagane
Buffalo
Blood
30°
Dundee
Glencoe
Nqutu
Sundays
Klip
Ladysmith
Nkandla
Bergville
Tugela
Colenso
Buffalo
Mhlume
Eshowe
Little Tugela
29°
Estcourt
Kranskop
Greytown
Mooi
Mooi River
29°
Stongers
30°
31°
ALTITUDE
METRES
FEET
> 2750
> 9000
2000-2750
6500-9000
1400-2000
4500-6500
900-1400
3000-4500
300-900
1000-3000
0-300
0-1000
0 10 20 30 40 50 60 Miles
0 10 20 30 40 50 60 70 Kilometres

FIG. 3

PE/2


ECOLOGICAL REGIONS OF THE TUGELA BASIN
27°S
29°E
30°E
31°E
28°S
29°S
30°S
Volksrust
Wakkerstroom
Utrecht
Newcastle
Vryheid
Dundee
Nqutu
Ladysmith
Colenso
Tugela Ferry
Bergville
Winterton
Weenen
Eshowe
Kronskop
Gingindlovu
Estcourt
Greytown
Mapumulo
Mooi River
Nottingham Road
Stanger
A. COAST REGIONS
1 COAST LOWLANDS
2 COAST HINTERLAND
B SAVANNA REGIONS
3 VALLEY
4 INTERIOR BASINS
C. UPLANDS REGIONS
5 MIDLAND MIST BELT
6 HIGHLANDS
D MONTANE REGIONS
MOUNTAIN
20 0 20 30
KILOMETRES
20 0 20
MILES
FIG. 4

SECTIONS ACROSS TUGELA BASIN SHOWING PRINCIPAL VEGETATION TYPES IN RELATION TO GENERAL TOPOGRAPHY

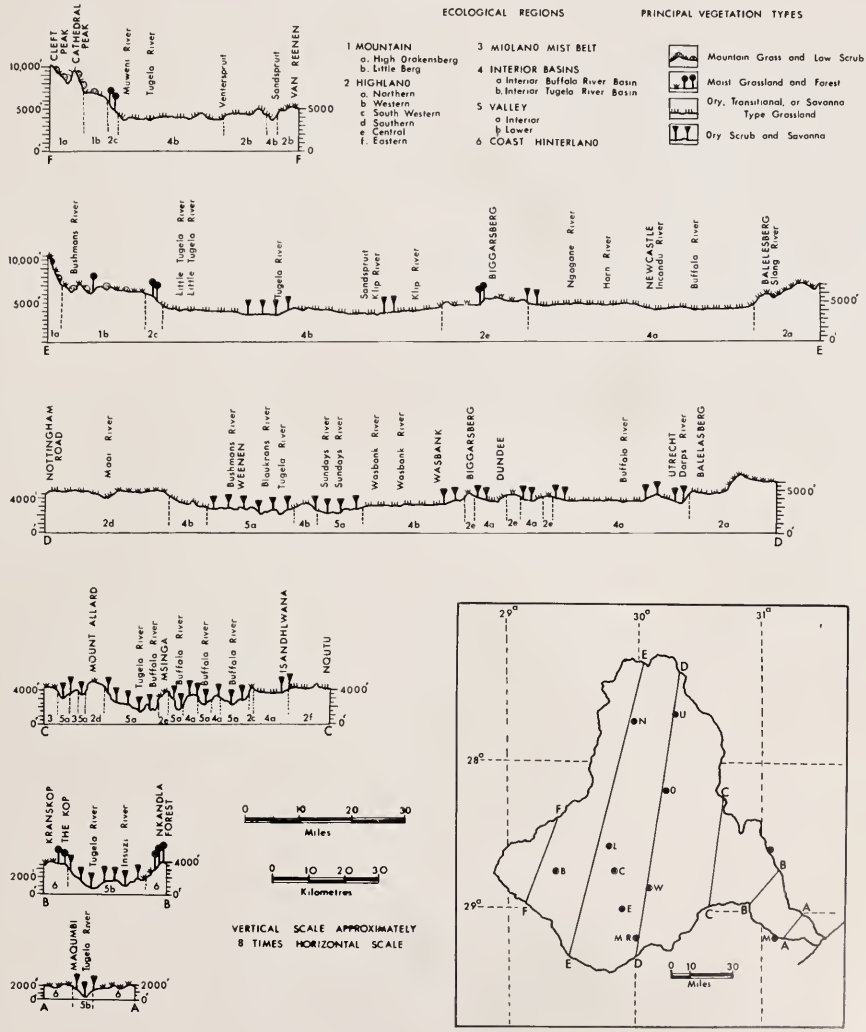


FIG. 5

(E) MIDLAND MIST BELT REGION

The Midland Mist Belt Region, between 3,500 ft and 4,500 ft altitude, is a narrow region found on both sides of the Valley Region. The topography is mainly steep. The Dwyka Series and Ecca Series, with numerous dolerite intrusions, are the underlying rocks.

(F) HIGHLANDS REGION

The Highlands Region extends from 4,500 ft to 6,500 ft altitude on the Ecca Series, the Beaufort Series, the Lower Stormberg Series, together with dolerite intrusions. South of the Tugela River the upper altitudinal limit is defined by the Cave Sandstone, which forms a constant and sharp escarpment to the Little Berg zone of the Mountain Region.

South of the Little Tugela River the Southern Highlands are composed of extensive areas of flat or rolling country, whereas rugged topography characterises the foothills of the High Drakensberg.

Between the Little Tugela and Tugela Rivers the South-western Highlands form a narrow belt along the foothills of the High Drakensberg. Here, the topography is steep and rugged, with rivers cutting far back into the Little Berg.

The Western Highlands, or Low Drakensberg, extend northwards from the upper Tugela River, to form a narrow belt of high ground rising in a steep escarpment, 1,000 ft to 2,000 ft above the Interior Basins Region.

The Northern Highlands, composed of the Balelesberg and Skurweberg Ranges, consist of a steep escarpment similar to that of the Western Highlands. The summit is an extensive flat or steeply undulating plateau, the highest point, Ntabankulu being 7,471 ft high. The Skurweberg extends into the Eastern Highlands as a number of hills hardly rising above the plains of the Interior Basins Region, and forming the divide between the Buffalo and Umfolozi Rivers.

The Central Highlands of the Biggarsberg, Helpmekaar and Msinga Ranges separate the Buffalo and Tugela catchments. The narrow plateau of the Central Highlands decreases in altitude from 5,500 ft in the west, to 4,500 ft in the east, where it is discontinuous, due to headward stream erosion.

The Eastern Highlands of the Qudeni and Nqutu Ranges rise to 5,842 ft on Qudeni, towering 4,300 ft above the Buffalo-Tugela confluence. Their narrow plateau is flat to undulating.

In addition to the more or less continuous highland ranges, there is a number of highland spurs and hills which have, in the course of time, become separated from their parent ranges due to erosion by rivers and general lowering of the land surface. Such conspicuous peaks and high hills are Job's Kop (5,696 ft), Impati (5,223 ft), Koenigsberg (6,546 ft), Leeukop (5,596 ft), Matiwane's Kop (5,374 ft), Nkwelo (6,857 ft), Ntanyane (5,003 ft) and Umhlumba (5,334 ft).

(G) MOUNTAIN REGION

This embraces the High Drakensberg, which rises to over 11,000 ft above sea-level, high above the general land surface of the Tugela Basin. From 6,000 ft to 7,000 ft, the Cave Sandstone spurs of the Little Berg form a narrow plateau or step. Above this are sheer basalt precipices that may attain 3,000 ft. A few spurs, partially separated from the main escarpment, have spectacular high peaks, such as Cathkin Peak (10,438 ft), Monk's Cowl, Mponjwane, Cathedral Peak (9,856 ft) and Sentinel.

Only a narrow section, up to two miles wide, of the Basutoland plateau is within the Mountain Region of the Tugela Basin. The undulating topography of this summit area is in sharp contrast to the cliffs and precipitous slopes of the escarpment zone below. On this summit area are found the highest altitudes in Africa south of Kilimanjaro and Meru.

CHAPTER 2

CLIMATE

Climatic conditions of the Tugela Basin are discussed under the headings of: insolation, temperature, winds, precipitation and relative humidity. Except for rainfall, climatic records are from less than 20 stations for the whole Basin. Rainfall and temperature data for the ecological regions are summarised in Table 6 at the end of this chapter. Additional climatic data are given in Appendix 1.

2.1 Insolation

Insolation data for the Tugela Basin, relating only to the duration of sunshine, are shown in Fig. 6 for Cathedral Peak in the upper Highlands Region, and for Estcourt in the Interior Basins Region. Results for Durban are included as representative for the Coast Lowlands Region. Data are for the five-year period from 1951 to 1955.

As may be expected, the duration of sunshine at the moist stations, Durban and Cathedral Peak, is generally less than at the drier station, Estcourt. During winter and early spring, sunshine duration at Durban is much less than at the inland stations but, during late summer, Cathedral Peak and Estcourt have a lower mean monthly sunshine duration than Durban. At Cathedral Peak the seasonal variation in mean monthly sunshine duration is considerably greater than at Durban.

Monthly values of over 90% of the possible sunshine, or over 8·5 hours daily, have been recorded at both inland stations during winter, but at Durban 87% is the highest recorded value. During late spring and summer, the monthly sunshine may be only 31% and 29% of the possible amount at Durban and Cathedral Peak respectively, that is, less than 4·5 hours daily. But at the driest station, Estcourt, 42% is the lowest value recorded.

As is well known, in the southern hemisphere north-facing slopes receive more insolation than the south aspects. Throughout the Tugela Basin, these differences in insolation give rise to significant differences in vegetation on the various slope aspects. In the Valley Region, for example, the altitudes of equivalent zones of vegetation on opposite slopes may differ by as much as 3,000 ft. At the same altitude, strongly xerophytic vegetation may be found on hot, dry, north aspects, while forest mesophytes occur on the cooler, moister, south-facing slopes.

2.2 Temperature

Temperature data available are for eighteen stations located in or close to the Tugela Basin. There are no stations in the Mountain Region. Temperature data are shown in Fig. 7 and in Appendix 1, Fig. A1 and Tables A3 to A12.

As in the publication *Temperature* (Weather Bureau, 1942), screen temperatures from 0·1°C to 2·8°C (32°F to 37°F) serve as criteria of light ground frost; temperatures from 0·0°C to −2·8°C (32°F to 27°F) are regarded as indicating moderately severe frost; and temperatures less than −2·8°C (27°F) as indicating severe frost. While estimates of frost thus obtained may not be completely accurate, because of inconsistent differences between screen and ground temperatures, the estimates undoubtedly give a more realistic impression of frost occurrence than would the adoption of the freezing point as a basis.

Temperature characteristics of the ecological regions of the Tugela Basin are summarised in Table 6 at the end of this chapter. These may best be discussed for each of the regions.

(a) COAST LOWLANDS REGION

Data are available for two stations only, Amatikulu and Stanger, located 10 miles north and 12 miles south, respectively, of the Tugela Basin. Temperature data from the two stations are similar and representative of conditions in the Coast Lowlands Region.

Mean daily maxima are high throughout the year: about 30°C during January and February, and over

25°C for at least nine months of the year. Absolute maximum temperatures of 40°C to 45·6°C have been recorded from September to March.

Mean daily minima are also high, between 10°C and 20°C throughout the year. The lowest recorded temperature is 3·9°C at Amatikulu. Though light frost has not been recorded at the two stations, it can, on rare occasions, be expected in valleys and depressions, where cold air settles during the evenings.

Local topographic effects on temperatures are evident at Amatikulu, in a small valley. Maximum temperatures are thus higher and minimum temperatures lower than at Stanger. Along the Tugela River, topographic effects on temperatures can be expected to be greater than at Amatikulu.

(B) COAST HINTERLAND REGION

Eshowe, about 12 miles north of the boundary of the Tugela Basin, has been selected to represent temperature phenomena in the Coast Hinterland Region. At 1,700 ft

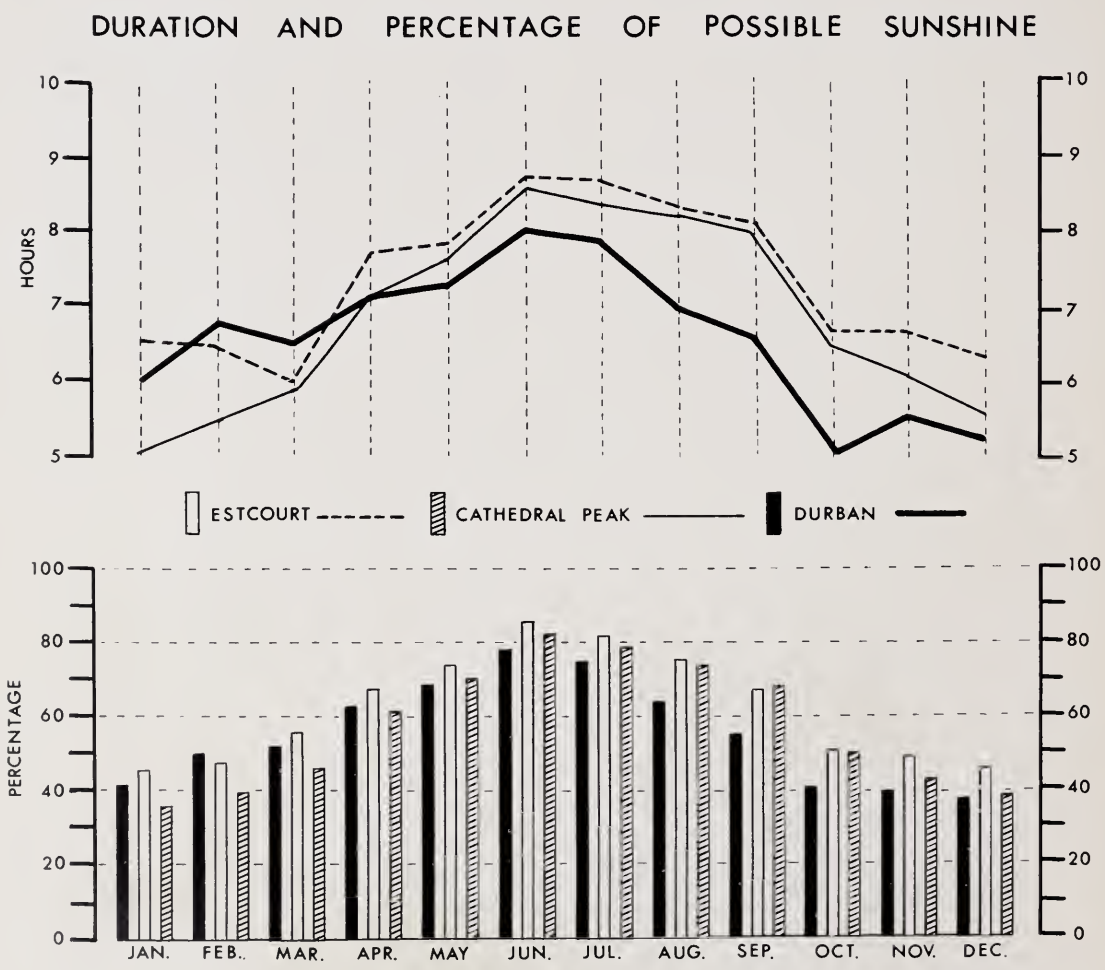


FIG. 6

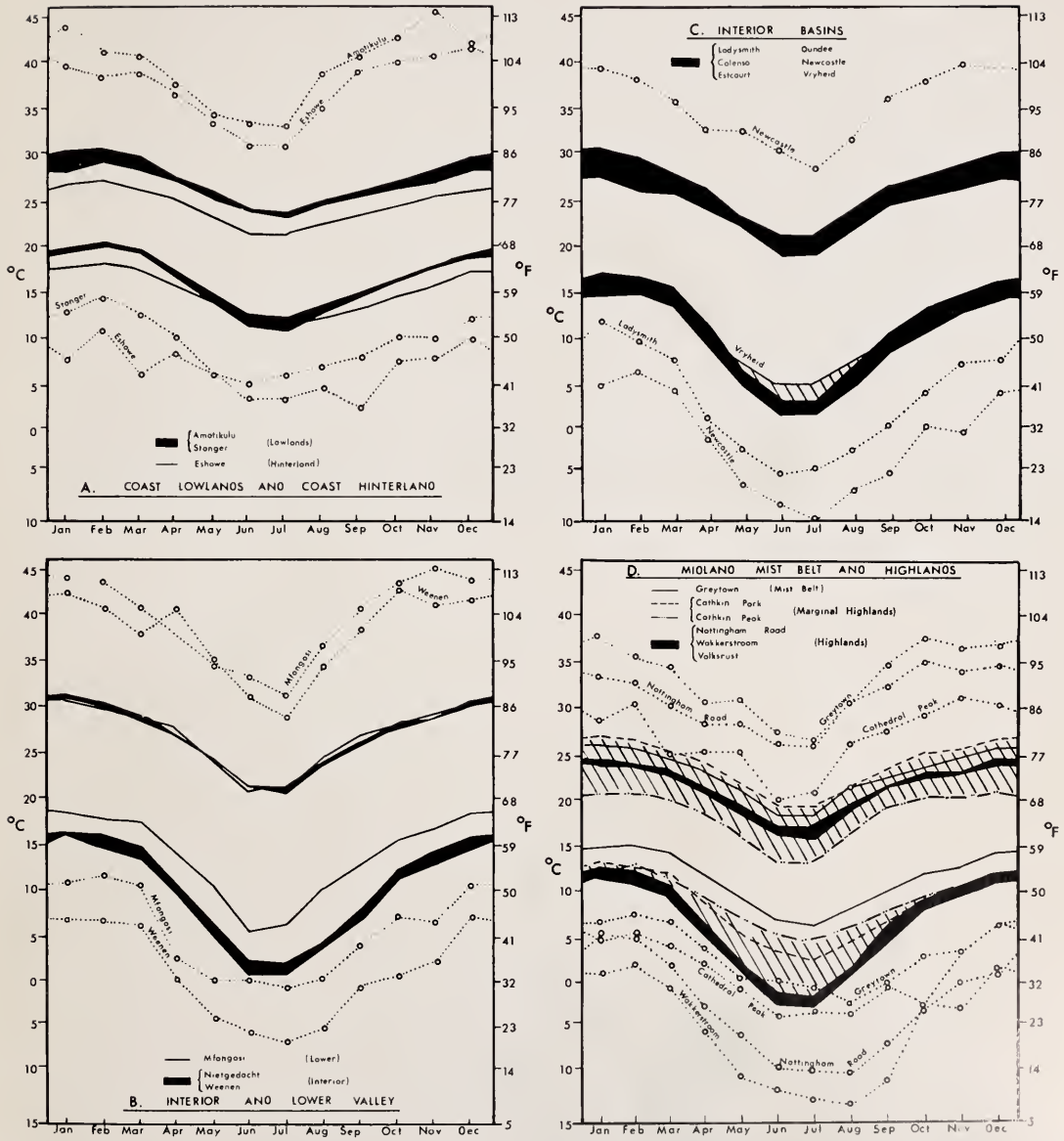

A. COAST LOWLANDS AND COAST HINTERLAND
Amatikulu
Stanger
Eshowe
(Lowlands)
(Hinterland)
B. INTERIOR AND LOWER VALLEY
Mfongosi
Nietgedacht
Weenen
(Lower)
(Interior)
C. INTERIOR BASINS
Ladysmith
Colenso
Estcourt
Dundee
Newcastle
Vryheid
D. MIDLAND MIST BELT AND HIGHLANDS
Greytown
(Mist Belt)
Cathkin Park
Cathkin Peak
(Marginal Highlands)
Nottingham Road
Wakkerstroom
Volksrust
(Highlands)
°C
°F
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

FIG. 7

elevation, the station lies at the warmer lower altitudes of the region.

The highest mean daily maximum temperature is 27·1 C in February. From November to April mean daily maxima are over 25°C. Absolute maximum temperatures over 40 C have been recorded from October to December, the highest temperature recorded being 41·7 C. Although the maximum temperatures are high, they are appreciably less than those of the Coast Lowlands Region.

Mean daily minimum temperatures are over 10°C throughout the year. The lowest recorded temperature is 2·3 C; light frost may occur.

Although temperature data are lacking for altitudes over 2,000 ft, they are expected to be similar to those for Eshowe with, however, generally lower maxima and minima, slightly higher daily and annual ranges, and occasional to frequent light frosts on flats and in valleys. The topography of the Region, generally, is steep, resulting in the drainage of cold air on calm nights into the Valley Region below. Because nights are warmer the inland upper altitudinal limit of the Coast Hinterland Region is at 3,500 ft, and not at 3,000 ft as suggested by the physiography. Nearer the coast at the Nkandla Forest, the upper altitudinal limit may even be at 4,000 ft, because of the strong oceanic influence on temperatures.

(c) VALLEY REGION

Temperature data for the Valley Region are from three stations: Mfongosi, Nietgedacht (near Muden) and Weenen.

Mean daily maxima are just over 30 C for two or three of the summer months, December, January and February; and over 25 C from September to April. Absolute maximum temperatures from 40 C to 45 C have been recorded for the months from September to April, the highest recorded temperature being 45·0 C at Mfongosi. Maximum temperatures in the Valley Region thus resemble those found in the Coast Lowlands Region, but in summer mean daily maxima are slightly higher, and in winter maxima become increasingly lower with increasing distance from the sea.

Although the maximum temperatures are similar throughout the Valley Region, minimum temperatures differ considerably in different parts of the region. Because of these differences, the ecological significance of which is borne out by the vegetation (Chapter 6), it is necessary to divide the Valley Region into the Lower Valley Sub-region east of the Buffalo-Tugela confluence, and the Interior Valley Sub-region west of this point (see also Chapter 1, (c)).

Mfongosi, at the western end of the Lower Valley Sub-region, is indicative of the furthest inland and less coast-like minimum temperature conditions of the Lower Valley Sub-region. During June and July mean daily minima are 6·7 C and 7·3 C respectively. Apart from these winter months, mean daily minima resemble those found in the Coast Lowlands Region. But the comparison of the absolute minimum temperature of −0·8°C at Mfongosi, with 3·9 C in the Coast Lowlands Region, is more significant than the comparison of mean daily minima. The lowest recorded temperatures at Mfongosi reveal moderately severe frosts from May to July, and light frosts in August. East of Mfongosi, moderately severe frosts become less frequent, until in the eastern part of the Lower Valley Sub-region they are absent.

In the Interior Valley Sub-region, minimum temperatures are much lower than in the Lower Valley Sub-region, and result in the highest mean daily ranges (14·1 C to 20·5°C) and annual temperature ranges in the Tugela Basin (Appendix I, Tables A9 and A10). Frost is indicated by mean daily minimum temperatures between 0·0 C and 2·8 C at Weenen and at Nietgedacht during June and July. Light frost has been recorded for eleven months of the year, and severe frosts from May to August. The lowest recorded temperatures are −4·2 C at Nietgedacht and −6·7°C at Weenen.

Because of the rugged topography, local climates in the Valley Region may differ considerably. Mfongosi, Nietgedacht and Weenen, on the valley floor, represent the most extreme local climates, as is well demonstrated by the high temperature ranges and annual temperature variations of these stations (Appendix I, Fig. A1 and Tables A9 and A10).

Local divergences of temperature can be ascribed chiefly to differences in insolation on different aspects (section 2.1), and to nocturnal temperature inversions resulting from the sinking of cold air. In the Interior Valley Sub-region, severe frost on flat areas along the valley bottom is shown by the data for Weenen and Nietgedacht. On the slopes above these stations, however, a number of frost-sensitive plants, for example, *Erythrina lysistemon* and *Euphorbia ingens*, are found. In the Lower Valley Sub-region, temperature inversions differ from those of the Interior Valley Sub-region by the absence of severe frosts, so that condensation from the valley mists is able to maintain grasses and herbs in a

Photo. 1. Heavy valley mist in Lower Tugela Valley, Oqaqeni, Mapumulo district. 0630 hours. 26/3/57. *Euphorbia tirucalli* Succulent Scrub in foreground.

Photo. 2. As in photo. 1, but evening with no mist. Note slope aspect complex on north side of Tugela River, and dense *Euphorbia tirucalli* Succulent Scrub in foreground and middle distance on south side of Tugela.

Photo. 3. Champagne Castle, ca. 10,000 ft. July. Midwinter frost action on soils in Mountain Region. Frost crystals in soil collapsing in early morning sun. Note soil perched on top of ice crystals, and the 'raked' appearance of the soil to left.

Photo. 4. Characteristic, crescent-shaped erosion scars on steep grass slopes in Subalpine Belt of Mountain Region (see text for explanation). Upper Mahai River valley. Royal Natal National Park.

Photo. 5. Strand vegetation on extensive sands at Tugela Mouth. Foreground: Pioneer colonies of *Scaevola thunbergii* and *Arctotheca nivea*. Middle distance: Semi-stabilized dune with *S. thunbergii* on low foredune, and *Ipomoea-Gazania* community on main dune. Distance: *Brachylaena-Mimusops* Scrub and Coast Dune Forest.

Photo. 6. Scaevola thunbergii plant completely exposed by wind removal of sand. Note continuous stem elongation with adventitious roots. Tape measure is 6 ft. Tugela Mouth.

Photo. 7. View south from Tugela Mouth showing strand vegetation. (i) Scattered colonies of *Scaevola thunbergii* nearest the sea. (ii) Low foredune covered by more closed community of *S. thunbergii*. (iii) On right of semi-stabilized dune in foreground is *Ipomoea-Gazania* community colonizing seaward to low foredune. Shown are *Ipomoea pes-caprae* (broad leaf), *Cyperus natalensis* (sedge), and *Gazania rigens* (rather small white plant). (iv) Right middle distance: invasion of *Ipomoea-Gazania* community by *Chrysanthemoides-Eugenia* Scrub. (v) Distance: *Brachylaena-Mimusops* Scrub nearer the sea, and Coast Dune Forest higher up on dune. Note that here the Dune Scrub and Dune Forest extend down close to the sea.

Photo. 8. Passerina Low Scrub in low-lying area behind first semi-stabilized dune at Tugela Mouth. *Brachylaena-Mimusops* Scrub on left. *Phragmites communis* Reedswamp along river beyond tent in distance, and in right central area of *Passerina* Low Scrub.

green condition for several weeks at the beginning of the dry season. The distribution of the large epiphytic orchid, *Ansellia gigantea*, is closely associated with valley mist formation.

(D) INTERIOR BASINS REGION

The temperature stations for the Interior Basins Region are Ladysmith, Colenso, Estcourt, Dundee, Newcastle and Vryheid. The first three are marginal to the Region. Although the stations are widely separated, they experience remarkably similar temperatures (see Fig. 7).

Maximum temperatures are lower than those in the Valley and the Coast Lowlands Regions. From September to April mean daily maxima are over 25° C, being about 30° C during summer for the stations closest to the Valley Region. Absolute maximum temperatures from September to April are between 35° C and 41·1° C.

Mean daily minima are between 1·0° C and 2·8° C during June and July. Exceptions are Ladysmith, 3·1°C and 2·9°C respectively, temperatures here being less extreme owing to the topographic siting of the station, and Vryheid where June and July mean daily minima are 5·1° C and 5·2° C respectively, suggesting a warmer temperature sub-region east of the Blood River. Frosts have been recorded from April to November, and severe frosts from May to September. At Vryheid, severe frost has been recorded during July and August only, but light frost has been recorded from April to November, as in most of the Interior Basins Region. The lowest recorded temperatures are between −5·0° C (Ladysmith) and −10·0°C (Newcastle).

Strong temperature inversions occur in the Interior Basins Region but, because of the even topography, local differences in temperature are less extreme than in the Valley Region.

(E) MIDLAND MIST BELT REGION

The only station for which data are available is Greytown, a few miles south of the Tugela catchment.

From December to February mean daily maximum temperatures are from 25° C to 26° C. Temperatures from 35° C to 37·9° C have been recorded from October to February. Maximum temperatures are thus considerably lower than at Eshowe in the lower Coast Hinterland, but are similar to those found in parts of the Highlands Region (see Fig. 7).

Mean daily minima in June and July are 7·1° C and 6·3° C respectively. Light frost has been recorded from May to September, and moderately severe frost from June to September. The lowest recorded temperature is − 2·1° C. In much of the Mist Belt Region minimum temperatures are likely to be higher than at Greytown, which is situated in a frost hollow. The minimum temperatures are lower than in the Coast Hinterland, but are higher than those occurring in the Highlands Region, this being the chief difference in the temperature characteristics of the Highlands and the Midland Mist Belt Regions.

(F) HIGHLANDS REGION

Temperature data from five stations are available for the Highlands Region: Nottingham Road, Volksrust and Wakkerstroom, the temperatures for which are remarkably similar, Cathkin Park at the warmer, lower altitudinal limits of the Region, and Cathedral Peak at the upper altitudinal limits where montane temperature characteristics become evident.

Mean daily maximum temperatures below 25° C throughout the year distinguish the Highlands from the Coast, the Valley and the Interior Basins Regions. During summer the absolute maximum temperatures are from 31·2° C to 38·9° C.

Minimum temperatures in the Highlands Region are of considerable significance for plants, shortening the growth period by about two months in comparison with the Interior Basins Region. Mean daily minima below 10° C for up to seven months from March to November, may be compared with about five months of such temperatures in the Interior Basins Region. From May to August, mean daily minima may be between 2·8° C and −2·8° C. Severe frost, a regular winter occurrence, has been recorded for up to six months of the year, and light frosts have been recorded even in summer. Apart from Cathedral Peak (−3·6° C), the lowest recorded temperatures are from −7·8° C (Cathkin Park) to −13·3° C (Wakkerstroom). Temperature records in a Stevenson screen on steep topography, particularly at high altitudes, must be accepted with considerable reserve because of the effect of cold air drainage. For instance, at Cathedral Peak, in the upper Highlands Region, Killick (1961) recorded a screen temperature of 11·0° C with a temperature at grass level of −14·6° C, a difference of 25·6° C.

Local temperature differences in the Highlands Region are important in areas of rugged topography such as along the Drakensberg, where, as a result of cold air drainage, minimum temperatures on slopes are considerably higher than on bottom lands.

(G) MOUNTAIN REGION

No temperature stations yet exist in the Mountain Region from 6,500 ft to over 11,000 ft on the High Drakensberg.

Temperature conditions are clearly of a mountain type, and different from those found in the other regions. Because of the high altitude, surface temperatures differ sharply between sun and shade, between north and south facing slopes, and before and after sunset and sunrise.

Severe frosts are a regular feature during winter, and heavy frosts have been observed even during early March and late November. On the night of the 15–16th July, 1956, an overnight minimum temperature below −18°C was recorded at grass level near the summit of Champagne Castle, the mercury level of the thermometer being below the graduated scale, having contracted into the minimum bulb.

During winter the surface soil is regularly frozen at night, and on steep south facing slopes at the highest altitudes may remain frozen throughout most of the winter. At lower altitudes, on north aspects and on flat areas, the soils are subject to alternate freezing at night and thawing by day (Photo. 3). Numerous, very characteristic crescent-shaped scars on steep grass slopes, are ascribed by King (1942) to soil slipping under the influence of snow. But Schelpe (1946), Killick (1963) and Troll (1944, cited by Killick), consider their formation to be due to frost action undercutting miniature ledges or terraces (Killick, 1963) (Photo. 4).

2.3 Wind

Information on winds in the Tugela Basin is taken mainly from the publication *Weather on the Coasts of South Africa* (1941).

During the summer, from December to February, the prevailing winds on the Coast Lowlands are north-east and south and south-west. The south and south-west winds have the highest average velocity, bringing cool weather, low cloud and rain to the coast area. Over the interior of the Tugela Basin, prevailing winds are south-east, east and north-east. The south-east and east winds are moist, frequently bringing low cloud and mist to the Coast Hinterland, the Midland Mist Belt, the Highlands and the Mountain Regions. South-west winds commonly herald frontal rains.

From March to May, the transition from summer to winter, the frequency of winds decreases. Over the interior, hot, dry Berg winds during autumn mark the onset of the dry season, and the deciduous character of various trees and shrubs becomes evident.

May, June and July are generally the calmest months of the year. Westerly winds begin to increase in frequency over the interior.

From August to November is the season of windy weather. On the coast north-east winds increase in frequency, spring being the worst season for gales, which may blow for several days. Most important are the hot, dry, north-west or Berg winds, especially frequent during August and September at the end of the dry season, when the fire hazard is especially great in the dry grasslands. These winds often reach gale force, becoming warmer as they lose altitude. When the winds reach the Coast Lowlands, extremely high temperatures may be experienced.

Very significant for plants, at the commencement of the spring growing season, is the low humidity of the Berg winds. During these winds, Bayer and Coutts (1938) recorded, in September and October at Pietermaritzburg, midday relative humidities as low as 5% and 9%, with temperatures of 36·1°C (97°F) and 38·9°C (102°F), respectively.

The slopes principally affected by the Berg winds are north to north-west to west facing, these slopes being also to leeward of the rain-bearing winds, as well as receiving the greatest amount of insolation throughout the year (section 2.1). In contrast to the north-facing slopes, south aspects on high hills and escarpments are exposed to moisture laden winds, and receive considerably less insolation.

2.4 Precipitation

Precipitation includes rain, snow, sleet, hail, mist, fog, dew and frost. Comprehensive precipitation data are available only for rainfall, the most important source of moisture for plant growth, and the factor that will be discussed chiefly in this section.

Rainfall data for some 200 stations were obtained (Weather Bureau, Annual Reports, 1926–1955) and plotted on a 1 : 250,000 scale base map. Field estimates of rainfall could thus constantly be checked against the rainfall stations. Data from 72 stations were analysed in detail, these stations providing a continuous 25 to 30 year record for the period 1926 to 1955. Exceptions were the stations Stanger, Greytown and Van Reenen's Pass, where data from 1914 and 1918 onwards were used to make up a 30 year period. Monthly and annual rainfalls for the 72 stations were plotted graphically,

and median and quartile values obtained to assess the variability of the rainfall. Mean rainfalls were calculated for the same 25 to 30 year period as was used for the determination of medians and quartiles, so that the means are directly comparable with the medians and quartiles (Appendix 1, Tables A13 and A14).

Mean annual rainfall isohyets for the Tugela Basin are shown in Fig. 8.

The mean, quartile and extreme values of annual rainfall are shown in Table 1, and the seasonal and half-yearly percentages of the mean annual rainfall are shown in Table 2.

Table 1. Mean, quartile and extreme values of annual rainfall

Ecological Region	Lowest	Lower Quartile	Upper Quartile	Highest	Mean Annual
Coast Lowlands					
1,001–1,250 mm. (2)	620	860–880	1,260–1,360	1,600–1,760	1,056–1,100
Coast Hinterland					
801–1,000 mm. (4)	460–600	680–760	1,020–1,140	1,380–2,020	872–961
1,001–1,250 mm. (2)	740–760	920–1,060	1,300–1,460	1,540–1,820	1,104–1,270
Valley					
601–700 mm. (6)	380–440	460–540	700–820	1,000–1,420	618–698
701–800 mm. (1)	480	600	900	1,050	759
801–1,000 mm. ? (0) ..	—	—	—	—	—
Interior Basins					
601–700 mm. (6)	260–450	520–600	740–800	1,020–1,320	643–697
701–800 mm. (17)	350–530	560–700	800–940	1,160–1,400	713–800
801–1,000 mm. (15)	360–530	650–800	900–1,340	1,120–1,960	804–1,000
Midland Mist Belt					
801–1,000 mm. (2)	600–660	740–800	1,060	1,440–1,660	960–961
1,001–1,250 mm. (0)	—	—	—	—	—
1,251–1,500 mm. (1)	1,040	1,160	1,700	2,000	1,125
Highlands					
701–800 mm. (3)	380–450	620–650	900	1,000–1,360	757–793
801–1,000 mm. (7)	400–600	660–860	920–1,060	1,040–1,620	806–978
1,001–1,250 mm. (4)	450–680	760–950	1,100–1,220	1,560–1,780	1,013–1,082
1,251–1,500 mm. (2)	800–830	1,000–1,080	1,480–1,530	1,840–2,090	1,251–1,332
Mountain					
1,501–> 2,000 mm. (0)	—	—	—	—	—

Figures in brackets are the number of 25 to 30-year stations on which data are based

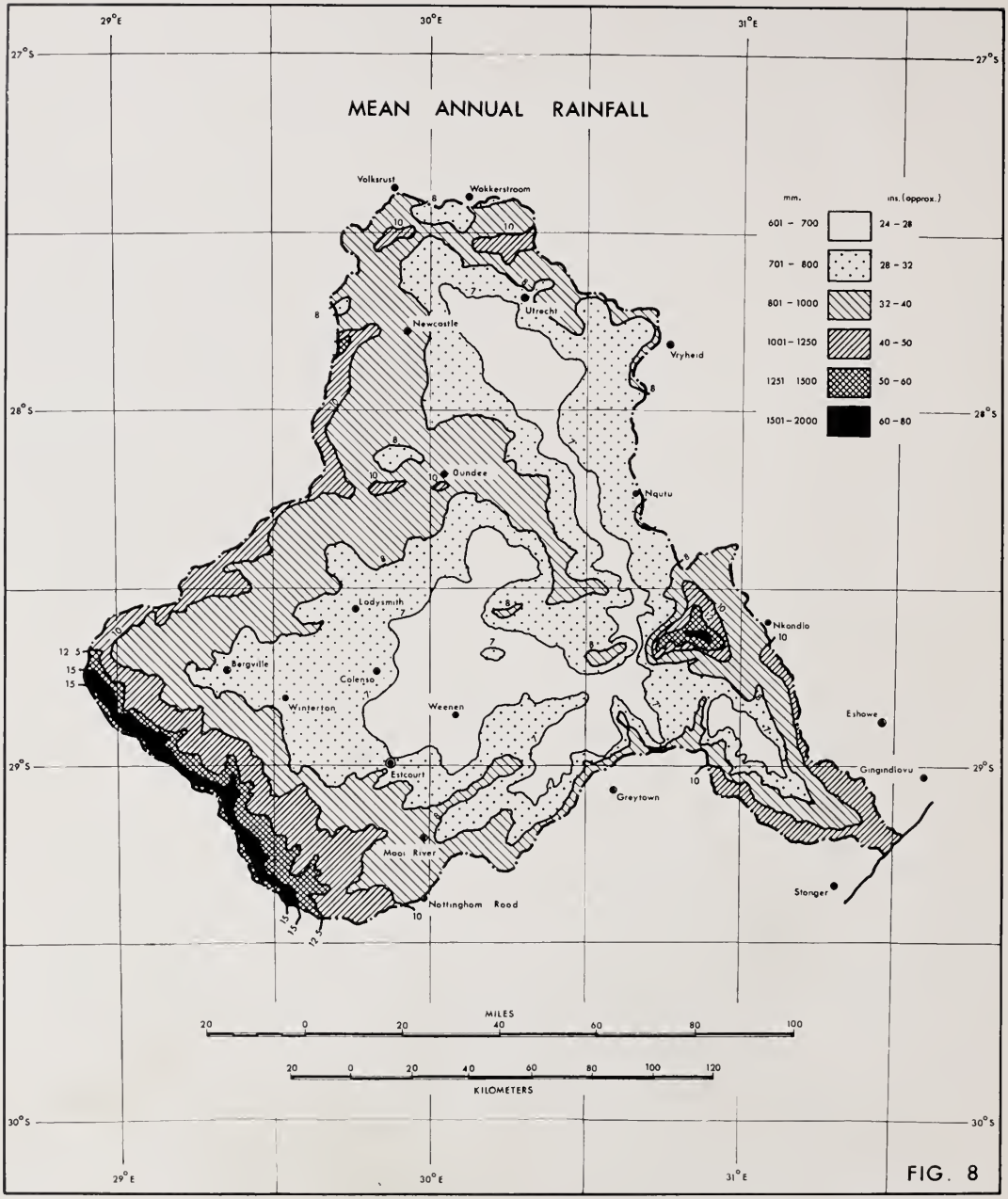

MEAN ANNUAL RAINFALL
mm.
ins. (approx.)
601 – 700
24 – 28
701 – 800
28 – 32
801 – 1000
32 – 40
1001 – 1250
40 – 50
1251 1500
50 – 60
1501 – 2000
60 – 80
29°E
30°E
31°E
27°S
28°S
29°S
30°S
Volksrust
Wakkerstroom
Utrecht
Newcastle
Vryheid
Dundee
Nqutu
Ladysmith
Nkondlo
Bergville
Colenso
Winterton
Weenen
Eshowe
Estcourt
Gingindlovu
Greytown
Mooi River
Nottingham Road
Stanger
MILES
20 0 20 40 60 80 100
20 0 20 40 60 80 100 120
KILOMETERS

FIG. 8

Table 2. Seasonal and half-yearly percentages of the mean annual rainfall

Ecological Region	D–F	M–M	J–A	S–N	O–M	A–S
Coast Lowlands .. (2)	36	26	10–13	25–28	67–71	29–33
Coast Hinterland .. (6)	40–44	22–23	7–9	26–28	74–78	22–26
Valley .. .. (7)	44–48	20–22	6–7	25–27	79–82	18–21
Interior Basins .. (38)	43–51	15–23	5–7	23–29	80–84	16–20
Midland Mist Belt .. (3)	43–56	20–22	6–8	26–29	77–81	19–23
Highlands .. .. (16)	46–52	18–24	4–7	23–29	79–85	15–21
Mountain .. .. (0)	—	—	—	—	—	—

Figures in brackets are the number of 25–30-year stations on which data are based

Monthly means and the reliability of the monthly rainfall from lower quartile data, are summarised in Fig. 9 (see also Appendix 1; Fig. A2 and Tables A13 and A14). Monthly lower quartiles indicate the minimum monthly rainfall with a frequency of 75%, that is, the lowest rainfall in a particular month which, on an average over a long period, may be expected to occur three out of every four years (see also Weather Bureau, 1957). Fig. 9 shows the mean monthly rainfalls, and whether the monthly lower quartiles are over or equal to 10 mm., 25 mm., 50 mm., 75 mm., 100 mm. and 150 mm. for all or only some of the rainfall stations in an ecological region. For example, Fig. 9 shows that for the Coast Lowlands Region there are two stations for which rainfall data are available for a 25 to 30 year period. The mean monthly rainfall is over 25 mm. for both stations throughout the year, but the monthly lower quartiles during June and July are not over or equal to 10 mm. at both stations. June and July rainfalls of at least 10 mm. should, therefore, not be expected to occur at least three out of every four years *throughout* the Coast Lowlands Region. Further, a comparison of the Coast Lowlands Region with the Interior Basins Region, shows that although lower quartiles *may* be over or equal to 10 mm. during June and July in the Coast Lowlands Region, they are *never* over or equal to 10 mm. from May to August in the Interior Basins Region.

In Fig. 10 hythergraphs show the seasonal variation of rainfall and temperature for the ecological regions. For simplicity, only certain stations are shown, hythergraphs of stations not shown resembling those in the figure.

The following is a brief discussion of precipitation in the ecological regions of the Tugela Basin.

(A) COAST LOWLANDS REGION

The mean annual rainfall of the Coast Lowlands Region is from 1,001 mm. to 1,250 mm., but over most of the region it is between 1,001 mm. and 1,100 mm., a higher rainfall being found near the sea in the Tugela Mouth area. No long-term rainfall stations have been established within the region, so data have been obtained from Stanger and Ginginhlovu, 12 miles south and 7 miles north of the Tugela Basin respectively. Both stations are representative of the Region.

From Table 2 and Fig. 9 it will be seen that the seasonal character of the rainfall is the least marked of all the ecological regions but is, nevertheless, well defined. Monthly lower quartile values may fall below 10 mm. during June and July. During the driest months of the year, June, July and August, it is rare for no rain to fall.

A feature of the coast stations is the occurrence of occasional extremely high rainfalls in almost any month of the year. Monthly means may thus be raised considerably, as at Stanger, where there was a fall of 622 mm. in March, 1925.

Rainfall in the Coast Lowlands is one of the highest,

the best distributed and the most reliable throughout the year, of all Regions in the Tugela Basin. Though high maximum temperatures tend to reduce the effectiveness of the rainfall, this influence is counteracted by higher atmospheric humidities than in other Regions.

(B) COAST HINTERLAND REGION

From 801 mm. to 1,250 mm. mean annual rainfall is found in the Coast Hinterland Region. Less than 1,000 mm. mean annual rainfall is received in the western part of the region and on the drier slopes abutting on to the Valley Region while, at the higher elevations east of Kranskop and Nkandla, the mean annual rainfall is from 1,001 mm. to 1,250 mm. Precipitation from low cloud and mist decreases in importance towards the Valley Region. South of the Tugela River the decrease in precipitation is rapid, the north-facing slopes being to leeward of the rain-bearing winds. North of the Tugela the decrease is less rapid, and thus the Coast Hinterland Region is from 1,000 ft to 3,000 ft lower in altitude than on the south side.

Table 2 and Fig. 9 show a more seasonal character to the rainfall than for the Coast Lowlands Region, Fig. 9 showing one to four months in the period May to August during which lower quartiles are below 10 mm.

Precipitation characteristics of the Coast Hinterland Region are intermediate between those found in the Coast Lowlands and in the Midland Mist Belt Regions. At the cooler, higher altitudes of the Coast Hinterland, such as at Nkandla Forest and at Kranskop, precipitation and temperature conditions tend toward those found in the Midland Mist Belt Region. At warmer, drier, lower altitudes towards the Valley Region, however, precipitation and temperature conditions tend more to resemble those found in the Coast Lowlands Region.

MEAN MONTHLY RAINFALL, AND MONTHS WITH RAINFALL OVER OR EQUAL TO 10mm, 25mm, 50mm, 100mm, AND 150mm, WITH A FREQUENCY OF AT LEAST 75%

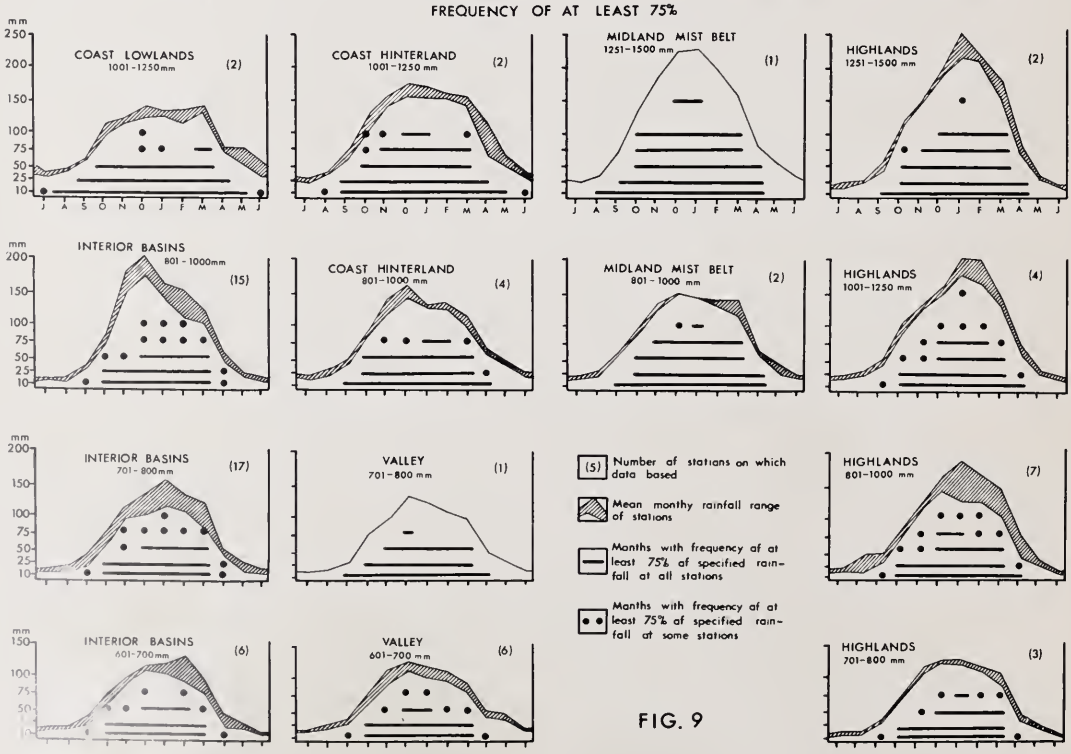

mm
COAST LOWLANDS 1001-1250mm (2)
COAST HINTERLAND 1001-1250 mm (2)
MIDLAND MIST BELT 1251-1500 mm (1)
HIGHLANDS 1251-1500 mm (2)
INTERIOR BASINS 801-1000mm (15)
COAST HINTERLAND 801-1000 mm (4)
MIDLAND MIST BELT 801-1000 mm (2)
HIGHLANDS 1001-1250 mm (4)
INTERIOR BASINS 701-800mm (17)
VALLEY 701-800 mm (1)
HIGHLANDS 801-1000 mm (7)
INTERIOR BASINS 601-700mm (6)
VALLEY 601-700 mm (6)
HIGHLANDS 701-800 mm (3)
J A S O N D J F M A M J
(5) Number of stations on which data based
Mean monthy rainfall range of stations
Months with frequency of at least 75% of specified rainfall at all stations
Months with frequency of at least 75% of specified rainfall at some stations

FIG. 9

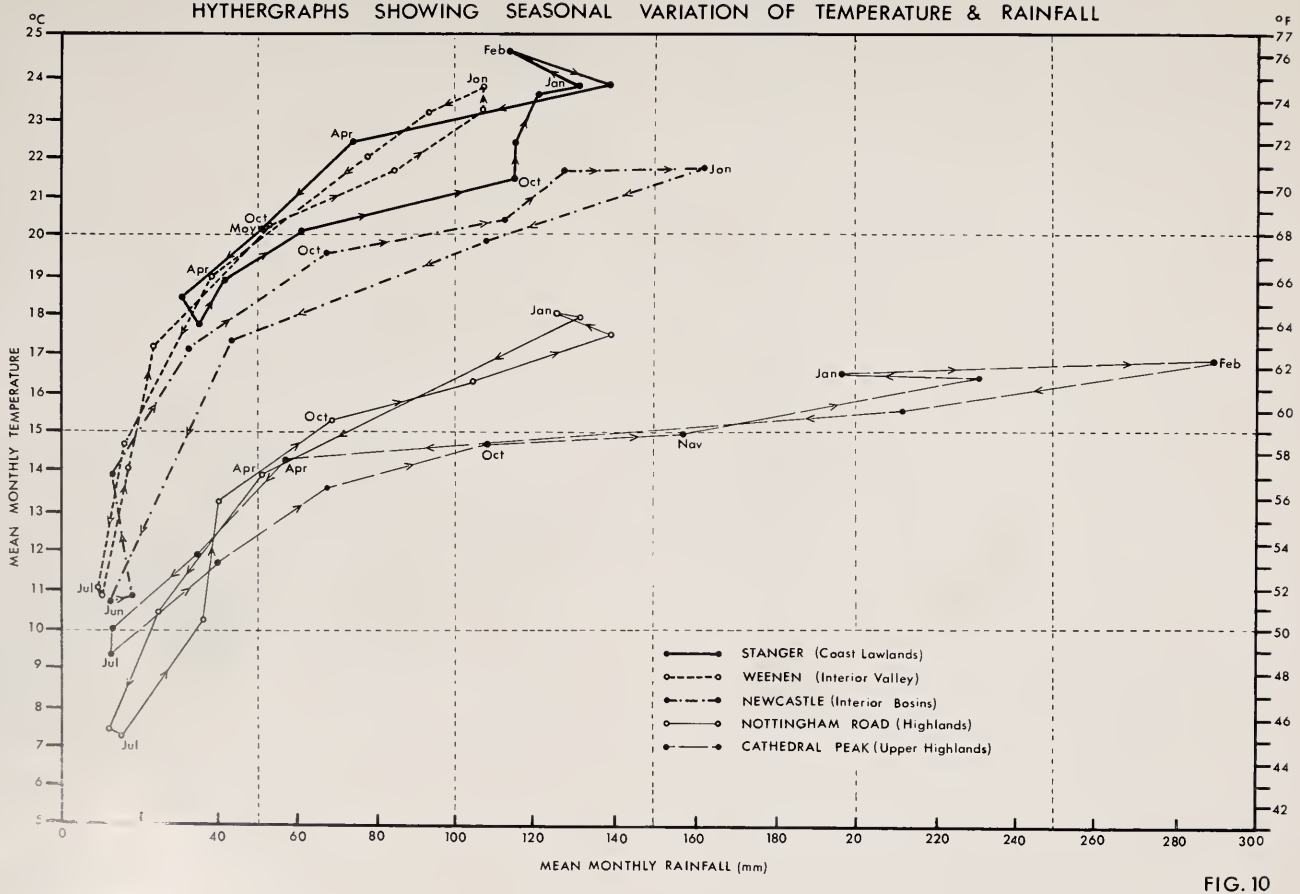

HYTHERGRAPHS SHOWING SEASONAL VARIATION OF TEMPERATURE & RAINFALL
°C
°F
MEAN MONTHLY TEMPERATURE
MEAN MONTHLY RAINFALL (mm)
STANGER (Coast Lawlands)
WEENEN (Interior Valley)
NEWCASTLE (Interior Basins)
NOTTINGHAM ROAD (Highlands)
CATHEDRAL PEAK (Upper Highlands)
Feb
Jan
Apr
Oct
May
Jul
Jun
Nov

FIG. 10

(c) VALLEY REGION

The whole of the Interior Valley Sub-region has a mean annual rainfall from 601 mm. to 700 mm. (see Appendix I). Mfongosi, at the western limits of the Lower Valley Sub-region, has a mean annual rainfall of 759 mm. Due to the absence of records, the rainfall received in the Lower Valley Sub-region east of Mfongosi is conjectural. On the standard rainfall maps (Lewis, 1938; Mackenzie, 1949; Weather Bureau, 1959) the rain-shadow effect of the high flanking ridges of the Tugela Valley appears to have been underestimated.

The extreme eastern limit of the most xerophytic vegetation types in the Tugela Valley is at the Otimati River confluence below Oqaqeni. In the Mandini area a relatively sharp change from xerophytic to more mesophytic vegetation is found. A mean annual rainfall of 601 mm. to 700 mm. thus appears likely from Jameson's Drift to the Mpisi River. East of the Mpisi River to beyond the Otimati confluence, a mean annual rainfall of 701 mm. to 800 mm. is probable; and from there to Mandini an annual rainfall of 801 mm. to 1,000 mm. From Jameson's Drift westwards to just beyond Mfongosi, the narrowest section of the Tugela Valley is in close proximity to the high rainfall Qudeni massif. As shown by Mfongosi (759 mm.), the mean annual rainfall in this section is from 701 mm. to 800 mm., therefore, higher, than to the west or immediately to the east.

Due to its west to east trend, nearly at right angles to the direction of the rain-bearing winds, the Valley Region is in a marked rain-shadow. In the Middledrift area, where the high northern flank of the Valley Region is some distance from the Tugela River, the rain-shadow area is of considerable width, xerophytic vegetation extending twice as far north of the Tugela as it does to the south. In the Mfongosi area, by contrast, the proximity of the high-rainfall Qudeni massif results in a narrowing of the rain-shadow area, and actually increases the local Valley Region rainfall. Thus the mean annual rainfall which falls on Qudeni, 4,760 ft at Woodlands, is 1,425 mm., to 759 mm. at Mfongosi at 1,400 ft altitude and only eight miles distant. Mfongosi may in turn be compared with Inadi, 2,630 ft altitude, twelve miles to the south-west, and high up in the Inadi River valley. At Inadi the mean annual rainfall is 631 mm., over 100 mm. less than at Mfongosi. Generally, the lowest rainfall in the Valley Region is found on the steep slopes south of the Tugela River.

As can be seen from Table 2 and Fig. 9, the seasonal characteristics of the Valley Region rainfall are more pronounced than for the Coast Regions, especially for the Interior Valley Sub-region. At the majority of the rainfall stations, with a mean annual rainfall between 600 mm. and 700 mm., lower quartile values are below 10 mm. for one or two months longer than in the Coast Regions. During the dry winter months, monthly medians are less than 5 mm. or nearly zero.

Precipitation from valley mists has been referred to in section 2.2 (c).

High temperatures in the Valley Region result in high evaporation which reduces the effectiveness of the rainfall. Because much of the Region consists of steep slopes with a poor plant cover, much of the rainfall runs away into streams and rivers without becoming available for plants. The Valley Region is the driest in the Tugela Basin.

(d) INTERIOR BASINS REGION

Mean annual rainfall in the Interior Basins Region is from 601 mm. to 1,000 mm. (Fig. 8).

The area with 601 mm. to 700 mm. mean annual rainfall is marginal to the Valley Region, extending north along the Buffalo River to between Newcastle and Utrecht. This rainfall is the same as that of the Interior Valley Sub-region, but in the Interior Basins Region the rainfall is more effective, since maximum temperatures are lower, the deeper soils retain more moisture and there is less run-off on account of the even topography.

Surrounding the Interior Basins Region area with from 601 mm. to 700 mm. mean annual rainfall, is a considerably larger area with a mean annual rainfall from 701 mm. to 800 mm. The upper rainfall limit frequently coincides with the boundary between the moister and drier types of grassland in the Interior Basins Region. For the dry season, lower quartiles are below 10 mm. from May to September, similar to the 601 mm. to 700 mm. mean annual rainfall area. From December to March lower quartiles are at least 50 mm.

In the western parts of the Interior Basins Region and along the Biggarsberg-Helpmekaar Range, there is a mean annual rainfall between 800 mm. and 1,000 mm. Under this higher rainfall, some lower quartiles in the rainy seasons occur a month earlier and a month later than in lower rainfall areas (Fig. 9).

Table 2 shows that for the Interior Basins Region there is a higher percentage of summer rain and a lower percentage of winter rain than for the Coast and Valley Regions. However, winter lower quartile and median data for the Interior Basins and Valley Regions are

Photo. 9. Bush Clump development in *Combretum gueinzii* community on steep, rocky slope. *C.gueinzii* invading the intervening *Aristida junciformis* grassland, which has not been burnt for several years. Large tree in clump at left is *Albizia adianthifolia*. Coast Lowlands Region.

Photo. 10. Coast *Acacia karroo-A.nilotica-A.robusta* Thorn Scrub and sugar cultivation typical of the Coast Lowlands Region. Note the dense character of the Thorn Scrub.

Photo. 11. Open *Acacia karroo* invasion on old cultivation in the Coast Lowlands Region. Note the coarse, luxuriant grass cover, unburnt for one or two years and only lightly grazed. Photos. 11–14 all taken on same site within very short distance of each other.

Photo. 12. Initial stage of bush clump formation on old cultivation in Coast Lowlands Region. Species here are *Scutia myrtina* (right, dark leaf), *Canthium inerme* (left, light leaf), *Pavetta lanceolata* and *Cissus sp.*

similar, monthly rainfall medians in both regions being generally nearly zero from June to August.

Much of the precipitation in the Interior Basins Region occurs in falls of high intensity, and there is less mist and low intensity precipitation than in the Highlands Region (see Tables 3 and 4 and (F)).

(E) MIDLAND MIST BELT REGION

For the Midland Mist Belt Region, the mean annual rainfall ranges from 801 mm. to over 1,500 mm. As shown in Table 2, and for the highest rainfall range in Fig. 9, the rainfall is more unevenly distributed through the year than for the Coast Hinterland Region.

The driest areas of the Midland Mist Belt, with a mean annual rainfall from 801 mm. to 1,000 mm., occur chiefly along the high ridges south of the Tugela River, and at lower altitudes in the Qudeni area. From 1,001 mm. to 1,250 mm. annual rainfall occurs around the core of high rainfall at the highest altitudes on the Qudeni Range (Fig. 8).

Where the mean annual rainfall is from 1,251 mm. to 1,500 mm., the reliability is high; at Woodlands the lowest recorded annual rainfall in 25 years is 1,047 mm. Despite the reliability of the high annual rainfall, there is a definite dry season and, in May and July, lower quartiles are less than 10 mm. From May to August lower quartiles are less than 25 mm. With the probable exception of the Mountain Region, where there are no long-term stations, the Midland Mist Belt Region is the only one in the Tugela Basin where lower quartile values of monthly rainfall are over 100 mm. for the six months from October to March. In December and January lower quartile values are over 150 mm.

The chief feature of precipitation for the Midland Mist Belt Region is the abundance of orographic mist and low cloud, which provide considerable moisture for plants. Maximum temperatures are relatively low and the principal periods of moisture stress are during the Berg wind periods (section 2.3). The lowest rainfall areas are almost entirely on north-facing slopes, so it is chiefly these driest areas, with a mean annual rainfall less than 1,000 mm., which are exposed to the desiccating north-west winds. The reduced intensity of insolation on the south aspects also contributes to the effectiveness of the precipitation, so here moisture relationships for plants are the most favourable in the Tugela Basin.

(F) HIGHLANDS REGION

From 701 mm. to 1,500 mm. mean annual rainfall occurs in the Highlands Region.

The driest areas, with a mean annual rainfall of 701 mm. to 800 mm., are found in the Northern Highlands and at lower altitudes transitional to the Interior

Table 3. Mean frequency of days with thunder and hail

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Interior Basins														
Estcourt ..	Th	16·0	12·6	11·9	7·0	1·9	0·6	0·2	1·1	3·0	8·1	13·1	15·2	90·7
	Ha	0·8	0·6	0·4	0·1	0·2	0·0	0·1	0·0	0·1	0·7	1·2	0·7	4·9
Ladysmith ..	Th	11·6	8·8	7·4	2·8	1·2	0·2	0·4	0·9	2·3	8·5	12·0	11·0	67·1
	Ha	0·3	0·5	0·1	0·1	0·3	0·0	0·1	0·0	0·1	0·3	0·6	0·8	3·2
Newcastle ..	Th	11·4	8·1	7·1	2·6	0·8	0·0	0·5	0·9	3·6	8·1	10·1	11·7	64·9
	Ha	1·1	0·1	0·3	0·0	0·1	0·0	0·0	0·0	0·0	0·3	1·3	0·5	3·7
Highlands														
Nottingham Road	Th	13·0	11·3	9·8	4·3	2·4	0·6	0·6	1·2	4·2	9·1	11·4	13·8	81·7
	Ha	0·6	0·5	0·4	0·2	0·2	0·2	0·0	0·1	0·1	0·0	0·8	0··	3·4
Wakkerstroom ..	Th	—	—	—	—	—	—	—	—	—	—	—	—	—
	Ha	0·6	0·3	0·2	0·1	0·2	0·1	0·0	0·1	0·2	0·2	1·5	0··	3··

Basins Region. The rainfall is accompanied by lower temperature maxima than are found with an equivalent rainfall in the Interior Basins Region. As can be seen by comparing figures for Wakkerstroom and Nottingham Road in Table 4, a lower precipitation, with less low intensity precipitation, distinguishes much of the Northern Highlands from the remaining areas of the Highlands Region.

A mean annual rainfall of 801 mm. to 1,000 mm. is found chiefly in the Central and Southern Highlands. Although the total annual rainfall is the same as that in the most humid areas of the Interior Basins Region, temperatures are lower in the Highlands Region, and precipitation intensities for the Highlands and Interior Basins Regions are by no means the same, as was shown by Scott (1951). In the Highlands Region there are more rainy days, and low intensity precipitation contributes more to the total amount than for the Interior Basins Region. In Table 4, for example, Nottingham Road in the Highlands Region, with a mean annual rainfall of 845 mm., experiences almost the same number of days with a rainfall over or equal 10 mm. as does Newcastle in the Interior Basins Region, with a higher annual rainfall of 917 mm. But at Nottingham Road there is an average of 131·5 days with at least 0·2 mm. of rain, compared with 87·1 days at Newcastle.

From 1,001 mm. to 1,500 mm. mean annual rainfall occurs mainly above 5,000 ft altitude in the Highlands Region. The highest mean annual rainfall is found at about 6,000 ft along the Drakensberg.

Most of the Highlands Region resembles the Interior Basins Region and the Interior Valley Sub-region in that median values from June to August are less than 5 mm. At the higher altitudes, where mean annual rain-

Table 4. Mean number of days with rainfall above specified limits

	Mean year	mm.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Interior Basins															
Estcourt	736	> 0·2	13·1	12·4	11·0	6·0	2·9	1·4	2·3	1·8	4·2	9·2	13·0	14·0	91·3
(20 years)	mm.	> 1·0	11·1	11·3	9·5	4·9	2·7	1·1	1·7	1·4	3·5	7·4	10·5	12·1	77·2
		>10·0	3·3	3·7	3·0	1·5	0·8	0·4	0·4	0·5	0·6	1·7	3·4	3·5	22·8
Ladysmith	788	> 0·2	13·1	11·9	11·9	6·1	3·8	1·8	2·0	2·1	4·3	11·1	11·5	13·0	92·6
(10 years)	mm.	> 1·0	11·6	9·3	8·5	4·9	2·7	1·1	1·5	1·7	3·6	8·6	9·2	10·5	73·2
		>10·0	3·9	3·8	3·2	1·9	0·3	0·5	0·3	0·7	0·8	2·8	3·0	3·2	24·4
Dundee	836	> 0·2	13·6	11·7	10·5	6·3	3·0	1·9	2·2	1·8	4·9	10·8	12·1	13·8	92·6
(19 years)	mm.	> 1·0	11·4	9·5	9·1	4·5	2·4	1·4	1·8	1·4	3·5	8·3	10·4	11·3	75·0
		>10·0	4·6	3·6	3·6	1·5	0·6	0·4	0·6	0·4	1·1	2·1	3·8	4·4	26·7
Newcastle	917	> 0·2	13·1	11·2	10·3	5·6	2·7	1·8	2·3	1·8	4·3	10·1	11·8	12·1	87·1
(20 years)	mm.	> 1·0	11·1	9·9	9·1	4·7	2·1	0·9	1·7	1·4	3·6	7·9	10·0	10·7	73·1
		>10·0	5·3	4·4	3·5	1·5	0·9	0·4	0·5	0·5	0·7	2·5	3·3	4·3	27·8
Highlands															
Nottingham	845	> 0·2	17·5	16·0	15·4	8·9	4·5	3·1	3·7	4·5	7·9	14·1	16·8	19·1	131·5
Road	mm.	> 1·0	13·9	12·9	11·7	6·5	2·7	1·9	2·1	1·9	4·7	9·9	13·1	15·0	96·3
(20 years)		>10·0	4·1	4·1	3·4	2·3	0·8	0·3	0·7	0·3	0·8	1·9	3·7	4·5	26·9
Wakker-	781	> 0·2	—	—	—	—	—	—	—	—	—	—	—	—	—
stroom	mm.	> 1·0	10·8	9·4	7·9	4·8	2·6	1·4	1·0	1·6	3·1	7·8	11·5	10·2	72·1
(17 years)		>10·0	4·1	3·2	3·1	1·6	0·6	0·5	0·6	0·5	1·2	2·6	4·5	4·5	27·0

fall is in the 1,251 mm. to 1,500 mm. range, August median values are between 5 mm. and 10 mm.

Mist and low cloud are significant contributors to precipitation in the Highlands Region, but are more seasonal and less frequent than in the Midland Mist Belt Region.

Snow is an irregular and minor contributor of moisture in the Highlands Region.

In the more rugged areas along the Drakensberg, local rainfalls may differ considerably. Because of higher temperature maxima and a lower rainfall, the vegetation in deep valleys exhibits characteristics transitional to that of the Interior Basins Region.

(G) MOUNTAIN REGION

In the Cathedral Peak area, the mean annual rainfall of the Mountain Region is from 1,501 mm. to over 2,000 mm. Three gauges at 6,500 ft, 7,500 ft and 9,600 ft altitude have recorded, over three to ten years, mean annual rainfalls of 1,589 mm., 2,017 mm. and 1,609 mm. respectively. With increase in altitude from the Highlands Region, the rainfall increases to a maximum between 7,500 ft and 9,600 ft, decreasing westwards from the summit of the escarpment until at Mokhotlong, 25 miles south-west of Cathedral Peak, it is only 562 mm. (Killick, 1963).

Mist and cloud contribute much to the precipitation, but violent thunderstorms are common during summer. Snow occurs annually, but only on south aspects does it lie longer than for a week or two at a time. During winter, melting snow has been observed to raise soil moisture to saturation point for a short time.

Precipitation in the Mountain Region is the highest in the Tugela Basin, but montane climatic characteristics—high insolation, snow, soil freezing and frost action on soils—result in plant-soil moisture relationships quite different in character from those found in other ecological regions.

2.5 Relative Humidity

Humidity records for the Tugela Basin are limited, and the mean relative humidity data that are available, are of comparatively little value for ecological purposes. Data are shown in Table 5 and in Fig. 11, for Ladysmith, an Interior Basins Region station marginal to the Valley Region. These mean values provide an indication of the average seasonal and diurnal trends, though the average values are of less significance for vegetation than extreme values, such as were recorded by Bayer and Coutts (1938) during Berg wind conditions (see section 2.3).

Table 5 and Fig. 11 show that the lowest mean values of relative humidity, below 35%, occur in the afternoons, at about 1500 hours, from June to September. Particularly important for plants are the lowest mean relative humidities under the Berg wind conditions of September, when both temperatures and atmospheric saturation deficits are high.

The highest mean relative humidities, from 90% to 94%, occur from January to March in the early mornings at about 0600 hours. During winter and early spring, the highest mean relative humidities in the early mornings are between 75% and 80%. When Berg winds blow continuously for several days, the highest diurnal relative humidities are considerably lower than the mean values.

According to Killick (1963), relative humidities below 30% are common at Cathedral Peak at 6,100 ft, especially in late winter. Less than 10% humidity is recorded between five and ten times annually, while 5% or less is recorded occasionally. Despite the high mean annual rainfall at Cathedral Peak (1,418 mm.), compared with Ladysmith (778 mm.), the extreme relative humidities at the two stations would appear to be similar, though at Ladysmith saturation deficits are likely to be greater because of the higher temperatures.

2.6 Summary and Conclusions

The Tugela Basin is divided into seven ecological regions in each of which there is an essential uniformity of climate. The regions may be grouped into four main types as follows:

A. Warm, humid; Coast: (*a*) Coast Lowlands Region
(*b*) Coast Hinterland Region

B. Warm, dry; Savanna: (*c*) Valley Region
(*d*) Interior Basins Region

C. Cool, humid; Uplands: (*e*) Midland Mist Belt Region
(*f*) Highlands Region

D. Cool, humid, Montane: (*g*) Mountain Region

The principal climatic features of the ecological regions are summarised in Table 6

Table 5. Mean hourly values of relative humidity (%) and temperature (°C) at Ladysmith (Weather Bureau, 1954)

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
1	%	86	85	87	83	79	71	68	67	69	75	82	84	78
	°C	17·6	18·2	17·0	13·8	9·6	6·4	6·3	9·6	13·1	14·9	15·9	17·5	13·3
2	%	87	87	89	84	81	73	71	70	72	77	84	86	80
	°C	17·2	17·7	16·5	13·4	9·0	5·8	5·6	8·9	12·4	14·3	15·4	17·1	12·8
3	%	89	89	91	86	83	75	73	72	75	79	85	87	82
	°C	16·8	17·3	16·0	12·9	8·6	5·2	5·0	8·5	11·9	13·9	15·1	16·8	12·3
4	%	90	91	93	87	84	77	75	73	76	80	85	88	83
	°C	16·5	16·9	15·7	12·5	8·1	4·8	4·5	7·9	11·4	13·6	14·8	16·5	11·9
5	%	91	91	93	88	85	79	75	75	77	80	86	89	84
	°C	16·3	16·6	15·4	12·1	7·8	4·3	4·3	7·6	11·0	13·4	14·5	16·3	11·6
6	%	90	92	94	90	87	81	77	75	79	81	85	87	85
	°C	16·6	16·4	15·2	11·7	7·5	3·9	3·9	7·3	10·7	13·3	15·0	16·7	11·5
7	%	82	87	92	90	87	82	78	76	77	75	77	79	82
	°C	17·9	17·5	15·9	11·9	7·3	3·5	3·5	7·2	11·3	14·9	16·6	18·2	12·1
8	%	75	77	83	83	83	79	76	72	69	67	69	71	75
	°C	19·5	19·3	17·7	14·2	9·3	4·9	4·6	9·2	13·9	17·1	18·3	20·1	14·0
9	%	68	69	72	71	71	67	67	62	58	58	61	65	66
	°C	21·0	21·1	19·7	16·7	12·4	8·3	8·3	12·3	16·6	19·3	20·3	21·8	16·5
10	%	62	63	65	61	58	55	55	53	50	52	55	59	57
	°C	22·6	22·7	21·6	19·0	15·3	12·0	12·0	14·9	18·9	21·1	22·1	23·1	18·8
11	%	58	58	59	55	51	46	47	47	44	47	49	55	51
	°C	24·1	24·3	23·3	21·0	17·7	15·1	14·7	17·0	20·7	22·6	23·7	24·5	20·7
12	%	53	54	53	50	44	39	41	41	38	43	45	50	46
	°C	25·4	25·5	24·8	22·5	19·5	17·5	16·9	18·6	22·4	24·1	25·1	25·9	22·3
13	%	50	51	49	47	41	35	37	39	35	39	41	47	43
	°C	26·5	26·5	26·0	23·5	20·7	18·9	18·3	19·8	23·7	25·1	26·2	26·9	23·5
14	%	48	49	47	45	38	33	35	36	32	38	40	45	41
	°C	27·1	27·1	26·8	24·1	21·4	19·6	19·2	20·6	24·5	25·7	26·6	27·4	24·2
15	%	48	48	46	44	37	32	33	34	31	37	39	45	39
	°C	27·3	27·3	27·1	24·4	21·5	19·9	19·5	20·9	24·7	25·7	26·7	27·3	24·4
16	%	49	49	46	45	37	31	33	34	31	38	40	46	40
	°C	27·3	26·7	26·8	24·0	20·9	19·4	19·1	20·7	24·3	25·2	26·2	26·8	23·9
17	%	52	53	49	47	41	35	35	35	33	41	43	50	43
	°C	26·2	25·7	25·7	22·7	19·1	17·4	17·4	19·5	23·1	24·2	25·0	25·6	22·6
18	%	57	55	55	55	47	39	39	40	39	45	49	55	48
	°C	24·3	24·7	23·6	20·1	16·5	14·5	14·6	17·0	20·8	22·3	23·3	24·2	20·5
19	%	62	62	63	60	51	43	43	45	45	53	55	61	54
	°C	22·7	23·0	21·7	18·5	15·2	13·2	12·8	15·5	18·7	20·4	21·4	22·4	18·8
20	%	69	67	67	65	59	48	47	48	51	58	63	67	59
	°C	21·1	21·7	20·7	17·3	13·9	11·5	11·3	14·1	17·2	19·1	19·9	20·8	17·4
21	%	73	73	72	70	64	53	53	51	57	63	69	73	64
	°C	20·2	20·7	19·7	16·4	12·7	10·1	10·1	13·1	16·3	17·9	18·6	19·8	16·3
22	%	79	76	77	74	69	59	57	57	61	67	73	76	69
	°C	19·3	19·9	18·9	15·7	11·8	8·8	8·9	12·1	15·4	17·1	17·9	19·1	15·4
23	%	82	79	81	77	73	65	62	61	65	70	77	79	73
	°C	18·6	19·2	18·2	14·9	10·8	7·7	7·7	11·3	14·5	16·5	17·1	18·5	14·6
24	%	84	83	84	80	77	69	65	64	67	73	80	82	76
	°C	18·1	18·6	17·6	14·2	10·1	6·9	7·0	10·6	13·9	15·7	16·5	17·9	13·9
Mn	%	70	70	71	68	64	57	56	55	55	60	64	68	63
	°C	21·3	21·4	20·5	17·4	13·6	10·8	10·6	13·5	17·1	19·1	20·1	21·3	17·2

MEAN RELATIVE HUMIDITY AND TEMPERATURE AT LADYSMITH AT 0600hrs. AND 1500hrs.

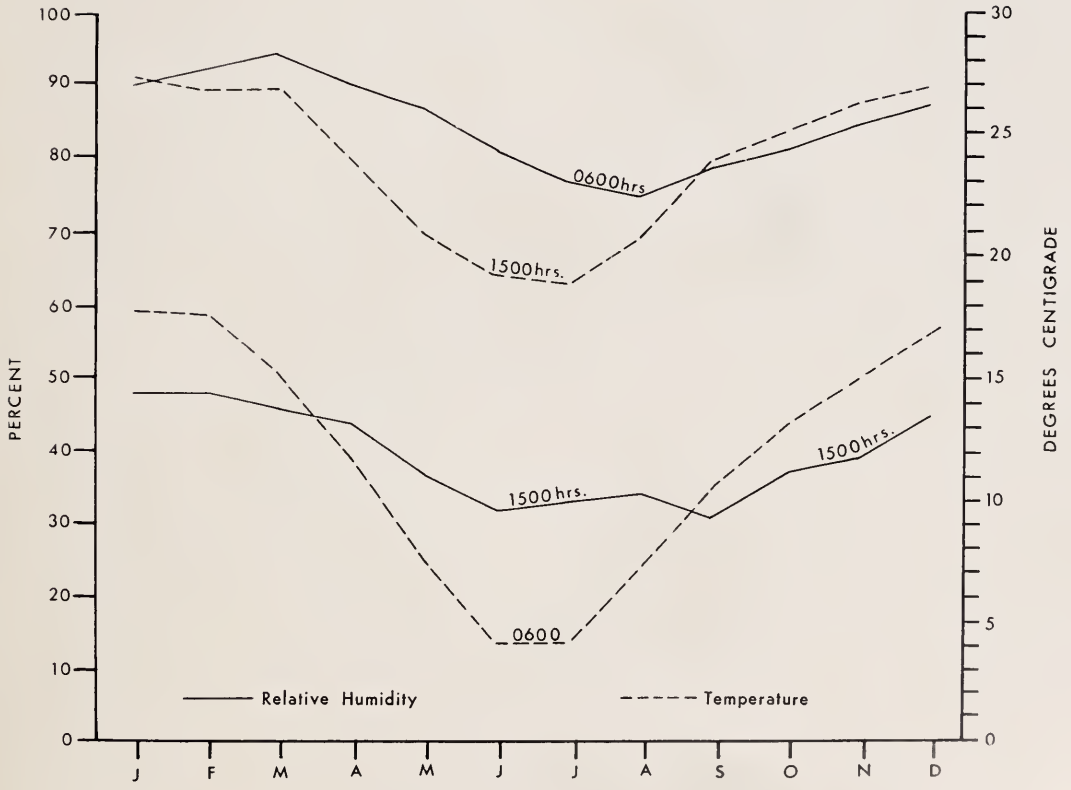


FIG. 11

Table 6. Summary of principal climatic features of the Tugela Basin

Ecological Region	Temperature			Rainfall
	Mean Daily Maxima	Mean Daily Minima	Frost—mths. (Extremes)	Mean Annual LQ[1] ⩾ 10 mm.
(*a*) *Coast Lowlands* 0–1,500 ft.	⩾25° C, ⩾9 mths. c. 30° C, 2 mths.	⩾10° C	None (Light, rare)	1,001–1,250 mm. LQ 10–12 mths.
(*b*) *Coast Hinterland* 1,500–3,500 ft.	25–28° C 6 mths.	⩾ (⩽) 10° C[2]	None to Light	801–1,250 mm. LQ 8–11 mths.
(*c*) *Valley*				
Lower	⩾25° C, 8 mths. and	⩾6° C	None to Light 1 (4) Mod. 0 (1)	601–?1,000 mm. LQ 6–? mths.
Interior	⩾30° C, 2–3 mths.	0–3 (⩾)[3] ° C[3] June, July	Light 0–5 (1–11) Mod. 0–4 (0–6) Severe 0–2 (0–4)	601–700 mm. LQ 6–8 mths.
(*d*) *Interior Basins*				
Eastern	25–30° C 8 mths.	⩾5° C	Light 4 (8) Mod. 0 (5) Severe 0 (2)	601–1,000 mm. LQ 6–8 mths.
Western 3,000–4,500 ft.		0–3° C June, July	Light 4–6 (6–8) Mod. 3–4 (5–8) Severe 0–2 (3–5)	
(*e*) *Midland Mist Belt* 3,500–4,500 ft.	25–28° C 3 mths.	⩾6° C	Light 3 (5) Mod. 0 (4)	801–⩾1,500 mm. LQ 8–9 mths.
(*f*) *Highlands* 4,500–6,500 ft.	20–27° C 5–8–(10) mths.[4]	−3 to 5° C June, July	Light 5–8 (8–12) Mod. 2–6 (5–9) Severe 0–5 (2–6)	701–1,500 mm. LQ 7–8 mths.
(*g*) *Mountain* 6,500–11,000 ft.	—	Surface soil regularly frozen in winter	Severe, at least 6 mths.	1,500–⩾2,000 mm. —

[1] LQ = Lower quartiles
[2] Probably less than 10° C at extensive altitudes above 2,000 ft.
[3] Over 3° C on extensive valley sides
[4] 10 months at exceptionally warm station — Cathkin Park

CHAPTER 3

SOILS (By Dr. J. J. Van der Eyk)*

A great variety of soils is found in the Tugela Basin. As a result of the recent soil survey, about 80 different *soil series*† are now recognised in the region.

In the first instance, differences in climate are responsible for the occurrence of soils which have developed in widely diverging directions. Therefore, the soils of the Basin can be most conveniently arranged according to the ecological regions in which they are found, viz. the Highlands and Midland Mist Belt, the Interior Basins, the Valley Region and the Coast Regions.

Within each of these four groups of ecological regions, local differences in parent material and topographic position have caused the formation of many soil series with strongly contrasting characteristics. In most places, the different series are distributed in a complicated, mosaic-like pattern: large uniform areas of one soil series only are rare.

In the following discussion, the soils of the ecological regions are arranged in groups which, due to the prevailing soil forming process, have certain main characteristics in common. (Fig. 12.) As far as possible, the designation of these soil groups is in accordance with the classification of the Inter-African Pedological Service (S.P.I.).

(a) SOILS OF THE HIGHLANDS AND MIDLAND MIST BELT REGIONS

According to one outstanding property of the predominant soils, these regions may be referred to as the 'leached landscapes'. All well-drained uplands here are occupied by *ferrallitic soils*, whose high degree of leaching is caused by the high rainfall and relatively low temperatures of these areas.

Due to the prevailing moist conditions weathering is intense and, through percolation, the soils have been depleted of 'bases' such as Ca, Mg, Na and K as well as silica. Of the minerals originally found in the parent material only the unweatherable ones such as quartz are still present in the soil. For the rest, the soil residue consists mainly of highly weathered clay such as kaolinite and Fe and Al oxides.

The practical implication of these characteristics is that the natural fertility of the soils is very low; they are strongly acid and the small amounts of plant nutrients present are virtually confined to the topsoil which is relatively rich in organic matter. This chemical paucity, however, is counterbalanced by favourable physical properties. In most places, the soils are deep and their subsoils are very friable, porous and permeable. In general, their erodibility is low and with the exception of the sandy and shallow soils their production potential is high—provided they are fertilised heavily.

Distinction can be made between *red* and *greybrown* ferrallitic soils. The former have reddish brown topsoils merging into dark red to yellowish red subsoils. They have developed from dolerite and from mixed deposits which are at least partly of doleritic origin. Soils of the second group have formed from shale, sandstone or deposits derived from these rocks. Their greybrown topsoils are underlain by yellowish brown subsoils which, however, may turn reddish again at greater depths.

Both soil groups can be subdivided according to their textures. Parent materials derived from dolerite and/or shale give rise to predominantly clayey soils; where parent materials are wholly or partly of sandstone origin the soils have a more sandy texture.

The bottomlands in the leached landscapes are marshy vleis with *acid hydromorphic soils*. Their black topsoils are rich in organic matter; their subsoil usually consist of grey, firm clay with many [illegible] mottles. These soils are acid to strongly acid in [illegible]

* A detailed report on the soils of the Tugela [illegible] be available in this series at a later date.

† Soil series are the basic units of soil classification. They are differentiated according to significant variations in the morphological features of their soil profiles and in their chemical properties.

GENERALISED SOIL MAP OF THE TUGELA BASIN

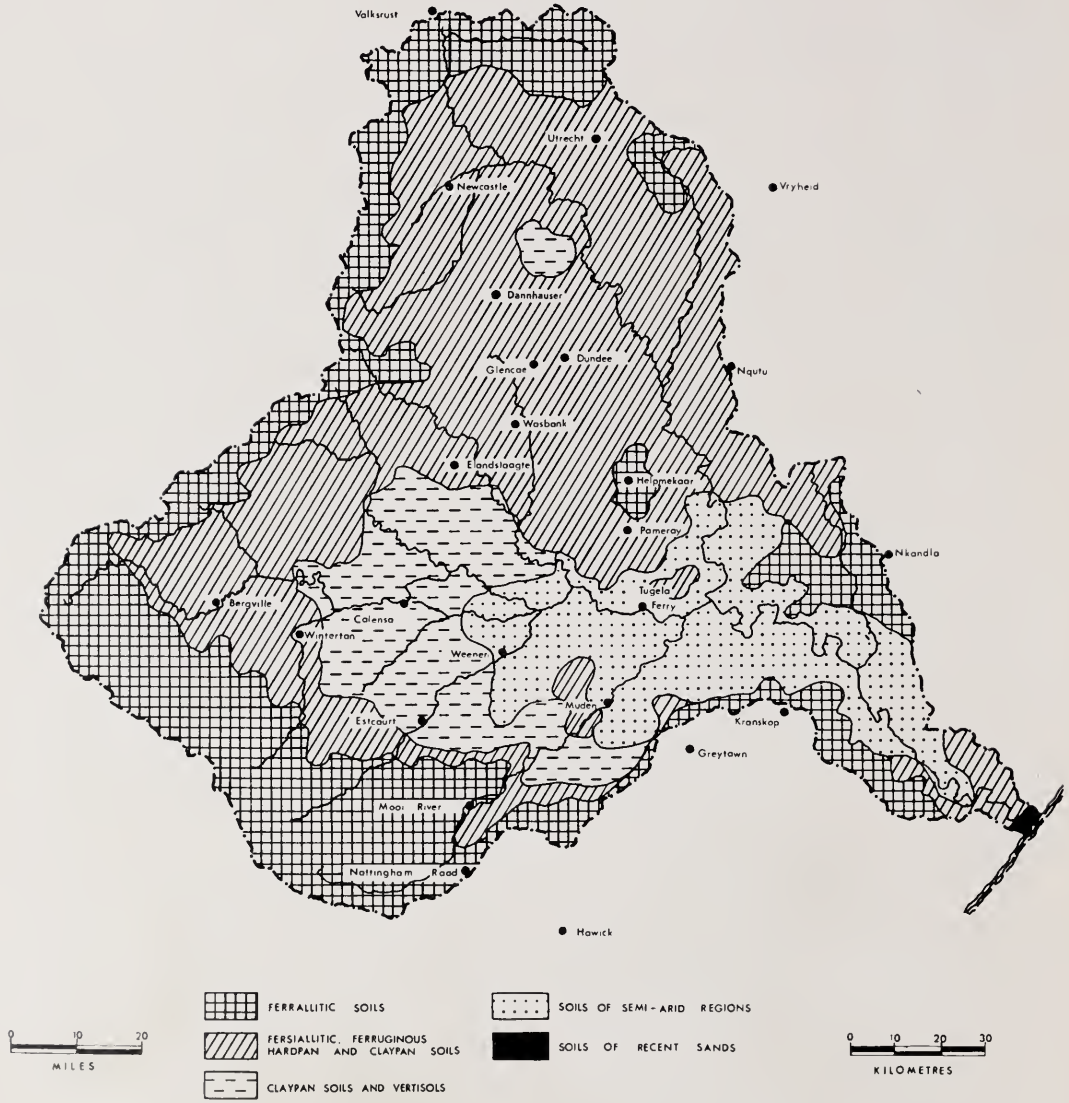


FIG. 12

Photo. 13. Intermediate stage of bush clump formation on old cultivation in Coast Lowlands Region. Small shrubs growing up around clump margin. Species in clump are *Pavetta lanceolata*, *Kraussia floribunda*, *Scutia myrtina*, *Ximenia caffra*, *Xeromphis rudis*, *Maytenus cymosus*, *Grewia occidentalis*, *Phoenix reclinata*, *Rhoicissus tridentata* and *Asparagus sp.*

Photo. 14. Late stage of bush clump formation on old cultivation in Coast Lowlands Region. Clump approximately 50 yards long and over 20 ft high in parts. Species include *Acacia karroo* (foreground), those of Photo 13 and numerous forest precursors and forest initials (see text, Chap. 5.)

Photo. 15. View northwest from Oqaqeni beacon OQ/NI28, Mapumulo area, Coast Hinterland Region. (i) Foreground: *Selago natalensis* society on rocky outcrop in *Aristida junciformis* Grassland. (ii) Semi-coast Bush Clump-Grassland Mosaic on relatively undisturbed, flat-topped mesa. (iii) Transitional Dry Coast *Acacia karroo-A.nilotica* Thorn Veld on slopes of mesa.

Photo. 16. View southeast from Oqaqeni beacon OQ/N128, Mapumulo area. (i) Foreground as in Photo 15. (ii) Middle distance: Marginal Valley Scrub of Otimati River gorge. (iii) Distance and other middle distance: Heavily populated Semi-coast Bush Clump-Grassland Mosaic in which most of the woody vegetation has been cleared.

Photo. 17. Upward invasion of *Acacia karroo* on old cultivated fields and eroded areas along lower boundary of the Coast Hinterland Region in the Nkandla Forest area. Grassland dominated by *Aristida junciformis*.

Photo. 18. Soil erosion of cultivated fields on steep slopes of sandy Table Mountain Series soils in Semi-coast Bush Clump-Grassland Mosaic at Oqaqeni, Mapumulo area. Lower Tugela Valley scrub and savanna vegetation in background. Foreground of Secondary *Aristida junciformis* Grassland, with relic Streambank Forest and Semi-Coast Forest at right.

Photo. 19. Secondary scrub relic of Coast Lowlands Forest near Mandini Hydroweir. Trees include *Ekebergia capensis* (right foreground), *Schotia brachypetala* (left foreground), *Acacia robusta, Chaetacme aristata, Ziziphus mucronata, Ficus natalensis, Antidesma venosum, Cussonia spicata* and *Acacia karroo.* Dominant shrubs are *Calpurnia subdecandra* and *Xeromphis rudis.* Other species are *Grewia occidentalis, Putterlickia verrucosa, Acokanthera oppositifolia* and *Euclea sp.* Climbers include *Uvaria caffra* and *Diospyros simii.*

Photo. 20. Interior of dense *Acacia robusta* Streambank Forest in Coast Lowlands Region. Other species shown are the palm, *Phoenix reclinata,* the shrub, *Calpurnia subdecandra,* and various species of Acanthaceae.

and their degree of saturation with bases is low. Due to the low permeability of the subsoil, these bottomland soils must be classed as moderately erodible. In some places, artificial drainage and cultivation have led to sheet- or even gully-erosion.

(B) SOILS OF THE INTERIOR BASINS REGION

The two large basins north and south of the Biggarsberg may be called the 'partly leached landscapes'. On the whole, they are warmer and drier than the Highlands and Mist Belt, but especially the rainfall differs considerably in various parts. Accordingly, several groups of upland soils can be distinguished here, ranging from those which are largely leached to those which actually show an accumulation of carbonates.

In this sequence, the first group is that of the *fersiallitic soils* which are predominant in the relatively moist parts of the Interior Basins. Although a large part of their bases has been washed out, a considerable proportion of the adsorption complex is saturated and a certain amount of weatherable minerals is still present in these soils. If not too sandy, their natural fertility is slightly higher than that of the ferrallitic soils, although their reaction is still acid to slightly acid. Of the clay fraction, kaolinite may be an important constituent, but less weathered clays such as illite are also present. Although Al oxides are lacking, the soils are rich in Fe oxides.

Many fersiallitic soils are, at least down to a considerable depth, friable, porous and permeable. Their erodibility ranges from low to medium. Due to the great variation in clay content and depth, their potential productivity ranges from high to low.

Again, distinction can be made between *red* and *greybrown* fersiallitic soils. The former have reddish brown topsoils merging into dark red subsoils; they have formed from dolerite and from mixed deposits with a doleritic component. The greybrown topsoils of the second group are usually underlain by a friable, yellowish subsurface horizon. Deeper down, the subsoils are strongly mottled with red and often contain large amounts of iron concretions. These soils have developed in the sedimentary 'veneer' covering the extensive pediments which occupy such an important part of the Interior Basins. In the southern Basin, these pedi-sediments are derived mainly from shale, thereby giving rise to predominantly clayey soils. In the northern Basin, the original source was mainly sandstone and consequently the soils often have a sandy texture.

Related to, and often intricately mixed with the greybrown fersiallitic soils are the *ferruginous hardpan soils*. Instead of mere loose concretions they contain a layer of indurated ironstone ('ouklip'), often situated directly underneath the topsoil.

Next on the scale of decreasing weathering and leaching is a group of *claypan soils*, which have their greatest extension in the relatively dry parts of the Interior Basins. They have developed from the same sedimentary parent materials on pediments as the greybrown fersiallitic soils, but their properties are very different. A large part of these soils shows the morphology of *solodised solonetzic soils*, characterised by greybrown, slightly acid to acid topsoils resting on a very dark grey to black, neutral to alkaline clay horizon. The latter has a distinct prismatic structure and its boundary with the topsoil is very abrupt. Deeper down, the subsoil merges into greybrown to olive brown, very firm and impermeable clay, of alkaline to strongly alkaline reaction and usually containing lime nodules.

Slowly weathered clays such as illite and mixed illite-montmorillonite are typical for these soils. The topsoils are partly leached, but the base saturation increases with depth; the deep subsoil is usually completely saturated, often to a considerable degree with Na.

Another part of the claypan soils actually consists of transitional forms between the greybrown fersiallitic soils and the solodised-solonetzic soils. In these cases the subsoil is not so dark and markedly prismatic but greybrown, often mottled with red. It lacks, however, the friable consistence and porosity of the fersiallitic soils, being hard and impermeable, with a blocky structure and heavy texture contrasting strongly to those of the topsoil.

Because their subsoils are extremely impermeable, the claypan soils are highly erodible. Over large areas, the increase in run-off caused by ploughing and overgrazing has led to severe sheet and rill erosion. Their agricultural potential is far more limited than that of the soil groups already mentioned.

A group of upland soils showing a still lower degree of weathering and leaching is that of the *vertisols* ('black turfs'). They have developed from dolerite or transported materials on pediments which are partly of doleritic origin. These soils are mainly found in the driest parts of the Interior Basins, where they tend to take the place of the red fersiallitic soils.

The upper horizons consist of black clay, neutral to mildly alkaline in reaction and highly saturated with bases. The clay is mainly montmorillonite; it shrinks

and swells with variations in moisture content, resulting in cracks and 'slickensides'. The subsoil shows an accumulation of lime, either finely dispersed or as veins or small nodules. It merges either into weathering dolerite or into a greybrown, hard clay of alkaline to strongly alkaline reactions.

Due to their low permeability the vertisols are highly erodible and ploughing of these uplands has usually resulted in widespread sheet and rill erosion.

The bottomlands of the Interior Basins vary from well-defined marshy vleis to somewhat concave depressions which are only slightly wetter than the adjoining uplands. The former are mainly found in the relatively moist areas. They are occupied by *neutral to alkaline hydromorphic soils*, consisting of dark grey topsoils overlying grey clay subsoils with plenty of brown and yellow mottling. They are to a high degree saturated with bases.

In the drier areas, the often ill-defined bottomlands consist mainly of solodised-solonetzic soils and vertisols, developed from colluvial or alluvial parent materials.

Naturally, the bottomlands form the drainage ways for both run-off and seepage water. Because their soils are highly erodible, most bottomlands in the Interior Basins have severely suffered from gully erosion. Especially in the wide slightly concave depressions, extensive donga systems have formed, often encroaching into the adjoining uplands.

(C) SOILS OF THE VALLEY REGION

In the hot and dry valleys of this region, the soils are highly, often even fully, saturated with bases. Accordingly, these valleys may be termed the 'unleached landscapes'. They are characterised by the occurrence of *reddish brown* and *greybrown soils of semi arid regions*.

The former are reddish brown clays developed in the colluvial material at the foot of the valley sides and in older alluvial deposits. The topsoils are mildly to moderately alkaline in reaction, while the subsoils are usually strongly alkaline. Free lime, in the form of nodules or powder is sometimes present already in the topsoil, and in any case at greater depth. Locally, the lime content may be very high and some soils even contain a solid lime pan. The clays consist of illite and, particularly in the subsoil, of montmorillonite.

These soils are highly erodible; apart from widespread sheet erosion, deep gullies have formed in many places. Cultivation under irrigation as frequently practised in these areas overcomes the erosion hazard but brings with it the risk that the soils become saline ('brak') if no precautions are taken.

The second soil group consists of hard, greybrown to dark brown soils developed from colluvial material mainly originating from sandstone. The reaction of the topsoils varies from neutral to moderately alkaline; in the latter case they may contain free lime, mostly in a finely dispersed form. With depth, they merge either into a very hard, calcareous clay or into sandstone in and above which large quantities of lime have accumulated. Sheet and gully erosion are widespread in these soils.

(D) SOILS OF THE COAST REGIONS

The resulting effect of rainfall and evapo-transpiration in the warm and humid Coast Lowlands is such that, where parent materials are similar, soils have developed which are comparable with those found in the Interior Basins Region. Thus, the soils formed from dolerite, shale, sandstone and their colluvia belong to the groups of red and greybrown fersiallitic soils, solodised-solonetzic and other claypan soils and vertisols as already discussed under (B). Soils in the Coast Hinterland are transitional from those of the Coast Lowlands to those of the Midland Mist Belt at higher altitudes (see (A)).

Parent materials specific to the Coast Lowlands are the 'Recent Sands'. These occupy a strip immediately behind the coast line and are believed to be of windblown origin.

In this strip, distinction is made between the reddish brown and the grey sandy soils. The former are of neutral to acid reaction and have a *fersiallitic* character. The grey sands are more generally acid in reaction. They are partly classified as *weakly developed soils on loose sediments* and, in depressions or other places where drainage is poor, as *acid hydromorphic soils*.

(E) MISCELLANEOUS SOILS

In all four of the regions mentioned above, strips of young fluviatile alluvium are found along the major rivers and some of the smaller streams. In these soils distinct horizons have not yet developed; hence they are classified as *juvenile soils on recent deposits*. Their properties vary widely; uniform greybrown sands may occur next to dark grey heavy clay. Many profiles show a distinct stratification caused by alternate layers of sand, silt, clay and sometimes gravel.

Soils of older river terraces often consist of reddish

brown sandy clay and belong to the group of *fersiallitic soils*.

Apart from the soils described above, it was found that roughly one quarter of the Tugela Basin consists of 'stony land', mainly made up of hills and steep valley sides. It is occupied by *rock outcrops*, *rock debris* and *lithosols*: very shallow, usually stony soils.

In the different regions, the proportions of stony land vary widely. It occupies by far the largest part of the Valley Region, and virtually the whole of the Mountain Region. Of the Interior Basins, only a relatively small part is stony land, whereas the Highlands, the Midlands Mist Belt and the Coast Regions take intermediate positions.

CHAPTER 4

HISTORICAL BACKGROUND

Historical factors invariably play an important ecological role, but their importance can scarcely be over emphasised in a country where the general pattern of land use has changed from primitive to modern within the last hundred years.

The influence of man upon the vegetation of the Tugela Basin can be divided into three periods:

(i) The Pre-Bantu Period
(ii) The Early Bantu Period
(iii) The Modern Period

4.1 The Pre-Bantu Period

Before the arrival of the Bantu peoples in the fifteenth and sixteenth centuries (Bryant, 1929), there were large herds of wild animals and the last of the Stone Age peoples, the Bushmen (Wilcox, 1950). The animal life included a variety of herbivores, such as elephant, hippopotamus, buffalo, zebra and numerous species of antelope (Roberts, 1951; Shortridge, 1934). Because they ranged freely over the country depending upon water supply and the state of the vegetation, overgrazing effects were localised and transitory. Their annual migrations between the Orange Free State and the higher parts of Natal (Barter, 1852), and their probable coastward movement during the dry season (Anonymous, 1850), provided an alternation of grazing, browsing and resting different in its effects from the continuous pasturing of cattle, sheep or goats during later periods, especially in the Modern Period (see section 4.3.2).

The effects of man on the vegetation were probably small, since the Bushman roamed the country in small clans and built no permanent habitations, living by hunting and on various plants.

Although natural fires caused by lightning, and even falling boulders (Wicht, 1945), have occurred since prehistoric times (Phillips, 1930), the use of fire by primitive man may also be of considerable antiquity. Clarke (1959) considers that a knowledge of fire-making spread to Southern Africa at the end of the middle Pleistocene. The most important influence of the Bushmen upon the vegetation probably lay in their periodic use of fire for hunting and in intertribal warfare (Backhouse, 1844, in Bartlett, 1957).

4.2 The Early Bantu Period

The Tugela Basin lay across the path of Bantu migrating into Natal and the Eastern Cape Province during the fifteenth and sixteenth centuries (Bryant, 1929). They settled almost entirely in the warmer ecological regions of the Basin at altitudes below 4,500 ft.

In comparison with the earlier Bushmen, the Bantu were considerably advanced in culture, living in communities in strong, relatively permanent habitations made of saplings, poles and grass. Cattle were their principal standard of wealth, but they also owned goats and fat-tailed sheep. Tillage of the land was based on a shifting system of agriculture.

In addition to its use for domestic and hunting purposes, the Bantu also used fire to provide green grazing for cattle. Veld was burned in any month of the year.

The Early Bantu Period lasted some three to four hundred years, ending in the first quarter of the nineteenth century. As early as 1575, Natal had been described as 'well-peopled', by the shipwrecked Portuguese captain Perestrello (MacKeurtan, 1930). Barter (1852), travelling through the Interior Basins Region between Colenso and Ladysmith in October 1850, recorded that: 'The whole of this country, now so solitary, bears marks of having once been thickly inhabited. On every side, the ruins of old cattle kraals, round enclosures of loose stones, meet the eye.'

Although the historical records suggest a considerable secondary influence, estimates of population densities indicate that these were certainly not comparable with those of the Modern Period (see also section 4.3). In 1816, at the end of the Early Bantu Period, the total Bantu population of Natal and Zululand was estimated

as 178,000 persons, an average density of five per square mile (Bryant, 1929), whereas in 1916 and 1946, the density of the Bantu Reserve populations were 60 and 97 per square mile respectively (calculated from data in Brookes and Hurwitz, 1957).

Because of the low population densities, there was relative freedom of movement and available space during the Early Bantu Period. Secondary effects would have been small and localised in the first half of the Early Bantu Period, when population densities were probably much lower than in 1816.

The Early Bantu Period ended with the reigns of Shaka (1818–1828) and Dingane (1828–1841). During Shaka's extensive conquests most of the Tugela Basin became almost completely depopulated and inhabited only by roaming bands of fugitive clan remnants (Bryant, 1929; Fynn, 1950; Isaacs, 1936). The general depopulation was especially marked in the Interior Valley Sub-region and in the Interior Basins Region, where it was noted as late as 1850, between Colenso and Ladysmith by Barter (1852).

The principal areas not affected by the general exodus of people were the Coast Lowlands and lower Coast Hinterland Regions, and the Valley Region east of Tugela Ferry and Keat's Drift (Bryant, 1929).

As a result of the general depopulation, most of the vegetation of the Tugela Basin enjoyed a period of relative freedom from disturbance. Wild animals increased, returning to their former haunts, as was observed by Isaacs (1936) for the coast area in 1830, and by Gardiner (MacKeurtan, 1930) in 1835 for the Highlands Region.

4.3 The Modern Period

The outstanding feature of this period was the entry of the European settler. Populations increased markedly, political and farm boundaries were fixed, settlement patterns were defined, domestic livestock replaced wild animals, and there was an intensified utilization of land and vegetation.

4.3.1 The Nineteenth Century

(A) THE BANTU

The peaceful reign of Mpande (1841–1872), Dingane's successor, saw the laying of the foundation of the present rural distribution of the Bantu. Immediately after Mpande's accession, there began a large scale return to Natal of Bantu who had fled from Shaka and Dingane. The considerable numbers of returning people is indicated by the doubling of the population estimates of the Colony, from 100,000 in 1849 to 200,000 in 1862 (Fair, 1953). The problems arising from the influx of returning refugees resulted in the appointment of the Natal Native Commission of 1846–7 (Brookes and Hurwitz, 1957). The Commission adopted the principle of dividing the land between Bantu and European by a system of Native Reserves or Locations. The fixing of boundaries and the survey of the location areas took time, but by 1864 the position of the Bantu Reserves was substantially the same as today. (Fig. 13.)

One objective of the reserve system was to provide a ready source of labour for the European farmers, but this did little to solve the labour problem. Thus a system of labour tenancy, whereby labour was given in return for squatting rights, became a permanent feature of the farm labour system. The labour farms developed chiefly in the Interior Valley Sub-region and in the Interior Basins Region.

The creation of the Bantu Reserves system between 1847 and 1864 was an event of considerable importance. Originally, there appears to have been a sufficiency of land for the Bantu (Brookes and Hurwitz, 1957), but the population increased rapidly after 1864, and had probably more than doubled by the end of the nineteenth century. The increase in population, coupled with the primitive Bantu agricultural system, led inevitably to the deterioration of vegetation and soils. Traditionally the numbers and not the quality of stock were important, and these must have increased enormously, both in the reserves and on the labour farms.

During the last decade of the nineteenth century, the reports of Resident Commissioners (Zululand Blue Books, 1889–1897) noted that the Bantu were gradually taking to the use of ploughs, wagons, carts and harrows, thus providing means for increasing the rate of soil and vegetation deterioration. In 1897 rinderpest killed great numbers of cattle and revealed that official estimates of stock numbers were considerably less than was actually the case (Zululand Blue Books, 1889–1897).

(B) THE EUROPEANS

The first European settlers in the Tugela Basin were the Voortrekkers, who arrived at the end of 1837. [illegible] in the following year, 3,840 Voortrekkers were [illegible] in two main laagers in the Bushmans and Little [illegible] valleys. It is significant that, with a vast depopulated area before them, they selected the, at present, eroded and scrub-covered Weenen area for one of the principal settlements.

After the British annexation of Natal in 1844, many of the Voortrekkers left the colony, the interior areas of the Tugela Basin remaining sparsely populated until 1880, the beginning of the sharp upward trend in population, which has continued to the present day. Coal mining commenced around Dundee in 1880, and the railway through the Interior Basins Region reached the northern border of the Tugela Basin in 1891. During the last decade of the last century, railways were extended to Greytown and to Mandini, stimulating the wattle (*Acacia mearnsii*) industry of the southern Midland Mist Belt Region and the sugar industry of the Coast Lowlands Region.

With the exception of irrigation settlements around Weenen and Estcourt, farming during the nineteenth century was mainly extensive on large farms, several thousand acres in extent, devoted mainly to cattle breeding. Sheep farming was introduced after 1855, an event of importance because of the close grazing habits of these animals and their association with autumn burning. The sparse European population continued the Bantu custom of veld burning to promote grazing. Owing to the risk of maintaining unburnt veld through the dry winter, and the need to provide early grazing, burning was largely in autumn or winter.

During the last quarter of the nineteenth century there was a growing demand for timber. In 1880 a commission was appointed to report on the condition and extent of forest lands. Great concern was expressed at the destruction of forests, the Bantu generally being regarded as the chief agents because of their methods of shifting cultivation and constant requirements for fuel, hut-building and enclosures around kraals and cultivated land. Other causes of forest destruction were the system of 'saw licences', the wasteful methods of felling and extracting the timber, theft and fire.

From Qudeni there was a considerable trade in timber with Natal, and the forest was heavily worked (Zululand Boundary Commission, 1880; Lister, 1902).

Fourcade (1889), in confirming the findings of the earlier commission, noted a further decrease in forest since 1880 and that the Bantu alone were as destructive to forests as 'fires and cattle put together'. He observed an abundance of recent gully erosion in the upper parts of the Tugela catchment.

Fourcade's observations on the comparative recency of this deterioration are well borne out by the history of population increase and distribution, indicating that to about 1850 population densities were relatively low, the Bantu population being spread over virtually the whole of Natal. The early Bantu undoubtedly caused changes in the vegetation, mainly in favour of grassland at the expense of woody communities. But these changes were relatively mild in comparison with those which became evident in the latter half of the nineteenth century. Apart from their activities in the indigenous forests, the influence of the Europeans was slight up to 1880, owing to their scattered and small numbers. Later, however, their effects became increasingly more evident with the extension of settlement, the rapid increase in population, the improvement of communications and the intensification of farming.

4.3.2 The Twentieth Century

From the beginning of the present century, disturbance of the vegetation became greater due to the continual growth in population, the expansion of commercial and agricultural enterprise and the greater exploitation of vegetation. The disturbance has been most severe in the Bantu areas, because of the relatively high human and livestock densities.

(a) THE BANTU AREAS

Three-quarters of the length of the Tugela River lies within or on the boundaries of the Bantu areas, shown in Fig. 13.

Agriculture in these areas consists essentially of extensive pasturing and cultivation, often in small patches and on steep slopes. The veld is continuously overgrazed. Shifting cultivation cannot be practised, as in the Early Bantu period, because of the limited land suitable and available for crop production.

Fire is employed to promote grazing. Until recently veld was burned in any month of the year. Over most of the Valley Region and in heavily populated areas of the Interior Basins Region, burning cannot today be practised because of insufficient grass due to overgrazing.

To the Bantu, livestock are still largely a symbol of wealth, numbers rather than quality of stock being more important. From Table 7, showing the average density of livestock per square mile and the percentage of the district stock in the Bantu areas, it is evident that goats are an important item. In the districts of Weenen, Umvoti, Estcourt, Dundee and Klip River, goats are largely the property of Bantu living on European-owned labour-tenant farms.

Goats are more numerous in the worst eroded and most poverty stricken areas. But although these animals are widely condemned as being amongst the principal

TUGELA BASIN
SHOWING MAGISTERIAL DISTRICTS, BANTU AREAS
AND NON-FARMING AREAS

FIG. 5

agents of veld deterioration, it is not always recognised that veld management is uncontrolled, and that they are often present in excess of the carrying capacity of the veld. Were it not for the presence of goats in most of the Valley Region, scrub encroachment would be a far more serious problem than it is today, a feature to be taken into account in rehabilitation schemes involving stock reduction.

Table 7. Average density of stock per square mile, and percentage of district stock in Bantu areas (1951)[1]

Magisterial District	Cattle		Sheep		Goats	
	Density	%	Density	%	Density	%
Lower Tugela / Mapumulo	42	66	3	85	16	83
Eshowe	99	93	8	10	57	100
Nkandla	87	88	37	94	54	99
Kranskop	95	54	13	20	101	94
Umvoti	60	18	24	6	27	30
Msinga[2]	93	98	57	99	235	100
Weenen[2]	93	0	37	0	115	0
Nqutu	106	96	97	97	51	100
Helpmekaar[2]	126	4	94	5	51	3
Estcourt[2]	81	16	37	12	17	47
Dundee[2]	104	16	53	13	24	24
Klip River[2]	101	17	126	5	44	31
Bergville[2]	72	43	39	2	9	8
Newcastle[2]	72	8	30	10	12	20
Utrecht	61	0	107	0	18	0

[1] Data based on Assistant Stock Inspectors' Returns, 1951

[2] Whole magisterial district in Tugela Basin

In addition to their effects upon vegetation through pastoral and agricultural practices, the Bantu obtain from the surrounding vegetation a continuous supply of fuel and other materials for domestic use (roughly 1,000 poles to a hut). Where the population is dense, only isolated relics of the original vegetation may be found.

Generally, the Bantu areas with the highest human and animal populations show the most severe results of biotic influences on vegetation. The increase in average population density per square mile for the principal magisterial districts from 1904 to 1951 shown in Table 8 is, to some extent, indicative of the increasing disturbance due to increase in population.

Population densities up to 300 per square mile are found in parts of the Valley and Coast Hinterland Regions close to lines of communication and with a local abundance of arable land (Fair, 1953). In these heavily populated parts of the Valley Region, the deterioration of vegetation and soils is extremely severe, the top soil being completely stripped over large areas with only a relic secondary vegetation remaining. Stock densities are well illustrated by those for Msinga (Table 7). The highest population densities, up to 420 per square mile, occur on private Bantu lands in the Interior Basins Region (Fair, 1953). Here donga, sheet and wind erosion are found, with a secondary low scrub vegetation replacing the grassland. Sparse populations occur only in the Buffalo valley and in the eastern Tugela valley between Mandini and the Mambula River. In both these areas are found almost the only extensive remains of the primary type grass stratum of the Valley Vegetation.

Attention may be drawn here to the excellent work done by the Bantu Affairs Department in certain reserves. This work shows clearly that the application of modern planning and conservation farming results in a rapid improvement of the veld and soil resources.

Photo. 21. View of extensive Semi-coast Forest, represented by the Nkandla Forest. The upper tree canopy is more or less continuous, with occasional emergents. The steep topography is to some extent obscured by the continuous forest cover, but is indicated by the exposure of the trunks of the larger forest trees on the steeper slopes.

Photo. 22. View of interior of Semi-coast Forest in the Nkandla Forest, showing saplings and lower storey species, larger medium sized trees of upper canopy and absence of field layer. Species shown include *Rinorea natalensis* saplings at left, and larger stems of *Cryptocarya latifolia*, *Xymalos monospora*, *Combretum kraussii* and *Nuxia floribunda*.

Photo. 23. Downward continuations of Semi-coast Forest from the Qudeni Forest along the Mfongosi River. Note Valley Scrub and Savanna in distance and the steeply tilted rock strata of the Insuzi series in the middle and near distance (see also Photo. 109).

Photo. 24. Retreating margin of the Nkandla Forest and its replacement by *Aristida junciformis* grassland. Note the abrupt margin and the absence of typical forest margin and precursor species, except locally on the extreme right. The tall forest trees, *Olea capensis*, *Nuxia congesta* and *Apodytes dimidiata*, together with forest understorey species such as *Pavetta natalensis*, are shown exposed to the recurrent fires in the grassland and to browsing and trampling by cattle.

Photo. 25. Tree veld secondary relic of Semi-coast Forest in *Aristida junciformis* Grassland. Some of the original forest trees still occur near the two streams. Oqaqeni, Mapumulo District.

Photo. 26. Final stage in the disappearance of a forest patch and its replacement by grassland. The large streambank trees are *Ficus capensis* and *Syzygium cordatum.*

Table 8. Average Bantu population densities per square mile in 1904 (Fair, 1953) and 1951 (Burrows, 1959)

Magisterial district	1904	1951	% *Increase*
Lower Tugela	64	98	53
Mapumulo	98	118	20
Eshowe	46	79	72
Nkandla	34	64	88
Kranskop	36	61	69
Umvoti	29	50	72
Msinga (1)	48	85	77
Weenen (1)	43	44	0
Nqutu	38	64	68
Helpmekaar (1)	—	28	—
Estcourt (1)	15	27	80
Dundee (1)	27	59	119
Klip River (1)	23	40	74
Bergville (1)	11	28	155
Newcastle (1)	27	44	63
Utrecht	8	20	150
Average			77

[1]Whole magisterial district in Tugela Basin

(B) THE EUROPEAN AREAS

These areas consist of two main groups (Fig. 13):

(i) Those in which vegetation is relatively free from utilisation and disturbance, namely, Game Reserves, Nature Reserves, Parks, Forest Department lands and a few small areas belonging to private individuals and municipal bodies. They are limited in extent, covering approximately 300 square miles, or 2·3% of the Tugela Basin, and are not further considered here, except to note that most of the grassland vegetation is burned usually at two-year intervals.

(ii) The farming areas, covering the greater part of the Tugela Basin.

Between 1904 and 1921, the rural population of the interior Tugela Basin increased by some 6,000 persons, by 1921 the number engaged in farming being substantially the same as at present (see Fair, 1955; Fair in Thorrington-Smith *et al.*, 1952).

Since the beginning of the twentieth century there has been a general intensification of farming, reflected in the upward trend in stock numbers and in areas under crop production (Hurwitz, 1957). Nevertheless, farming is still either largely *extensive* or *semi-intensive*.

Intensive farming is at present limited to the cultivation of sugar cane in the Coast Lowlands Region, wattle (*Acacia mearnsii*) in the Kranskop-Greytown area, irrigable crops around Muden, Weenen, Nkasini, Winterton and Utrecht, and intensive dairying around the larger towns such as Dundee and Estcourt. Under such a farming system, the indigenous vegetation plays a minor rôle, but its indicator significance is often unheeded. Moreover, there is a tendency to exploit unsuitable areas. The stabilising influence on soil and water resources of indigenous streambank and riverine vegetation is almost universally insufficiently recognised. The retention of fringing communities should be made obligatory.

Semi-intensive farming, based partly on cultivation and partly on the use of the veld, is practised

in the vicinity of the main roads and railways and in proximity to urban areas. The Interior Basins Region has thus become one of the principal areas of *semi-intensive* farming. Intensification in the eastern transitional areas, bordering on the dry Valley Region, has often proved uneconomic and to induce soil erosion and *Acacia spp.* scrub encroachment (Scott, 1951).

Over the remaining farming areas *extensive* systems are prevalent, stock relying entirely on the veld for sustenance. Remoteness from communications and urban areas is invariably associated with *extensive* farming, irrespective of whether humid regions, such as the Highlands, are more suited to *intensive* agriculture.

Cattle are fairly evenly distributed over the Tugela Basin, but sheep are more restricted. Since 1900 there has been a shift in the centre of the sheep farming industry from the Midland Mist Belt Region and south-eastern Highlands to the western, central and northern Highlands, as well as to the northern and western Interior Basins Region, where autumn burning is still practised.

The ecological effects of farming systems utilizing the veld result from fire, grazing and browsing. Apart from the 'sweet veld' areas of the Valley Region, where grasses are palatable throughout the year, most grassland is burned annually, biennially or occasionally at longer intervals, to remove the old material and stimulate fresh growth for grazing. The principal abuses of the practice arise from autumn burning to provide early grazing, too frequent burning and overstocking of new burns (see Scott, 1951). Continuous or sustained grazing is almost universally practised. It is an unspectacular, but most significant factor causing changes in grassland composition, since selective grazing inevitably arises because of differences in species palatability. 'Taming' the veld is a practice intended to reduce grassland from climax or later successional stages to those which are earlier and more palatable, but which often prove unstable. Commonly the purpose is to regulate the height of the grassland. The process is more widely spread than is generally realised. Continuous overstocking leads rapidly to veld deterioration and is, therefore, in its more extreme forms seldom found on European farms at present. However, it is not always recognised when deteriorated veld is overstocked.

The worst aspect of farming by Europeans exists on some labour-tenant farms of the Interior Valley Subregion and Interior Basins Region. High human and animal population densities, resulting in severe deterioration of vegetation and soils, resemble the most heavily populated Bantu areas. The high densities of goats for the Weenen area in Table 7 are in keeping with the high incidence of labour farms in the district.

CHAPTER 5

COAST VEGETATION

Coast types of vegetation extend nearly 60 miles inland from the sea. They are found in:

(i) The Coast Lowlands Region, from sea level to 1,500 ft altitude. Covering approximately 60 square miles, or 0·5% of the Tugela Basin, the vegetation consists chiefly of a narrow zone of littoral dune communities, and thorn scrub and impoverished forest patches further inland.

(ii) The Coast Hinterland Region, from 1,500 to 3,500 ft altitude. The vegetation covers some 360 square miles, or 3% of the Basin, consisting mainly of a mixed grassland and bush clump community at lower altitudes, grassland at higher altitudes and scattered forest.

5.1 Coast Dune and Estuarine Vegetation

This vegetation extends inland for a maximum of about 1·5 to 2 miles, but is generally only about a half to one mile wide where the sand dunes rise up fairly sharply from the sea. Near Tugela Mouth, the highest dunes are about 300 ft above sea level.

Coast dune and estuarine vegetation is subject to the salt spray carried inland by inshore winds. Plants frequently show evidence of deformation from the effects of salt spray.

5.1.1 Coast Dune Vegetation

Soils of the dune vegetation are typically loose, sandy and unstable. Blow-outs occur frequently and new dunes are continually being formed where the vegetation is absent or disturbed. Under the dune scrub and scrub-forest of later stages in the succession, the soils become darker and finer from the addition of organic material.

At the mouth of the Tugela River it is evident that the beach is extending seawards, probably a result of the mass of silt brought down annually by the river. Plant colonisation of the sandy beach is thus active. About half a mile south of the estuary, however, the sea is either undermining the dune scrub or there is at present a state of equilibrium between the land and the sea, with a very narrow zone of pioneer strand plants fringing the dune scrub.

5.1.1.1 Pioneer Strand Communities

(A) SCAEVOLA COLONIES

The earliest plants colonising the unstable, shifting sands are the succulents, *S. thunbergii* and *Arctotheca nivea* (Photo. 5), which form open, scattered communities from 1 ft to 3 ft high. Due to their capacity for continuous stem elongation and adventitious root production (Photo. 6), they are of importance in obstructing and restraining movement of the sand. Frequently the *Scaevola* Colonies result in the formation of a low, semi-stabilised fore-dune, as shown to the left in Photo. 7.

(B) IPOMOEA-GAZANIA ASSOCIES

Also occurring on the shifting dune sands is a more mixed community, from 1 ft to 3 ft high, in which the dominant species are *Ipomoea pes-caprae*, with long runners rooting at the nodes, and *Gazania rigens* (Photo. 7). An abundant associated species is the rhizomatous sedge, *Cyperus natalensis*. Common associated species are the succulents, *Carpobrotus acinaciformis* and *Scaevola thunbergii*.

Owing to its more closed character, the community is important in partially stabilising the dunes, which are then invaded by *Passerina* Low Scrub or by *Chrysanthemoides-Eugenia Scrub*.

(C) PASSERINA LOW SCRUB

A closed community up to 4 ft high, in which dominant species are the sclerophyllous low shrub, *P. rigida*, and the grasses, *Sporobolus virginicus*, *Imperata cylindrica*, occurs behind the fore-dune stabilised dune on which the *Ipomoea-Gazania* community is dominant (Photo. 8). The area is

low-lying with a high water table, the lowest areas being periodically inundated by the flood waters of the Tugela. The successional development of the community is thus linked also to that of the vlei hydrosere. Common associated species are *Carpobrotus acinaciformis*, *Aristida capensis*, *Chironia baccifera* and *Bulbostylis collina* (on moister soils), together with invaders from *Chrysanthemoides-Eugenia* and *Brachylaena-Mimusops* Scrub.

The community is semi-stable, but under disturbance the sand substratum is susceptible to blow-outs. As a result of accumulations of old grass from *Imperata cylindrica* and *Sporobolus virginicus*, the community is periodically burned, thus forming a stage in the dune succession at which the fire factor may enter. Any deflection of the succession towards a more fire-tolerant community such as grassland does not, however, appear to occur, probably owing to the sporadic occurrence of fire.

5.1.1.2 Coast Dune Scrub and Forest

(A) CHRYSANTHEMOIDES-EUGENIA SCRUB

On the inland side of the first semi-stabilised dune are found the scrub precursors to Dune Forest. In all these communities the effects of wind-blown salt spray are usually clear.

The earliest of these communities in the succession is a dense scrub community, 3 to 8 ft high, dominated by shrubs of *Eugenia capensis* and *Chrysanthemoides monilifera* (Photo. 7). Abundant or common associated species are the shrubs and small trees, *Carissa macrocarpa*, *Brachylaena discolor* and *Rhus natalensis*, the climber *Rhoicissus digitata* and the succulent *Carpobrotus acinaciformis* (in more open or marginal areas), together with invaders from *Brachylaena-Mimusops* Scrub.

The community generally forms a narrow zone on the exposed seaward side of the taller *Brachylaena-Mimusops* Scrub to which it gives way fairly rapidly in the normal primary succession.

(B) BRACHYLAENA-MIMUSOPS SCRUB

Brachylaena discolor and *Mimusops caffra* form a zone of dense scrub, from 8 to 25 ft in height, on the seaward side of the Dune Forest. Where the community is close to the sea, salt spray effects are marked and the trees or shrubs are stunted and deformed. The compact and continuous upper canopy increases in height from the sea landward as a result of the greater protection from salt spray afforded to growing points on the leeward side of the branches. In the normal primary succession the community is invaded by the less salt spray tolerant species of the Dune Forest. Where spray effects are marked, however, both *Brachylaena-Mimusops* and *Chrysanthemoides-Eugenia* Scrub are persistently stunted, serving as buffer zones protecting the more sensitive species of the Dune Forest.

Typical associated species of *Brachylaena-Mimusops* Scrub include the trees and shrubs *Allophylus erosus*, *Carissa macrocarpa*, *Eugenia capensis* and *Rhus natalensis*, and the climbers *Rhoicissus digitata* and *Scutia myrtina*, together with invaders from the Dune Forest.

(C) COAST DUNE FOREST

Coast Dune Forest is developed on the seaward facing high dunes, some distance from the shore. About half a mile south of Tugela Mouth, however, where the coast line becomes rocky, the sand dunes have been stabilised and salt spray is somewhat less, the Dune Forest approaches close to the high spring tide level.

The tallest trees are from 30 to 35 ft high, but the average height is lower, being 20 ft to 30 ft or less nearer the sea and on the more exposed steeper dunes where salt spray effects are more pronounced. At its best the community is a rather dense, stunted, low, evergreen forest. Because of secondary influences, it is commonly a dense, scarcely penetrable, evergreen scrub-forest. The continuous upper canopy is generally very dense and regular. *Mimusops caffra* is the dominant scrub-forest species near the sea.

Typical species of the upper canopy include:

Mimusops caffra	Erythroxylum pictum
Brachylaena discolor	Euclea natalensis
Allophylus erosus	Ficus natalensis
Acacia karroo	Sideroxylon inerme
Apodytes dimidiata	Strychnos innocua sub.sp. gerrardii
Chaetacme aristata	Teclea natalensis
Cordia caffra	Turraea floribunda
Diospyros natalensis	Ziziphus mucronata

Although *Acacia karroo* may occur as a fairly large tree, it does not regenerate under the dense scrub-forest, and is apparently a relic of an earlier seral stage, such as is found in one consocies about half a mile inland from the sea on the north side of the Tugela estuary.

Typical species of the lower layers of small trees and shrubs from 5 to 15 ft in height include:

Acokanthera oblongifolia	Grewia occidentalis
Canthium inerme	Heteropyxis natalensis
Carissa macrocarpa	Kraussia floribunda
Cussonia kraussii	Maytenus nemorosus
Dovyalis rhamnoides	Pavetta revoluta
Dracaena hookeriana	Peddiea africana

Deinbollia oblongifolia	Phoenix reclinata
Eugenia capensis	Rothmannia globosa
Fagara capensis	Strelitzia nicolai (moist
Grumilea capensis	areas)

Herbaceous and ground layer plants include numerous species of Acanthaceae, *Polypodium scolopendrium* (often epiphytic), *Dactyloctenium australe*, *Setaria chevalieri* and many others. Where the upper canopy is less dense *Digitaria diversinervis* is dominant.

Climbers are frequent, giving secondary forest its dense and tangled character. Typical species include (W = woody upper canopy species):

Acacia kraussiana (W)	Hyalosepalum caffrum
Asparagus falcatus	Pupalia atropurpurea
Cissus fragilis	Rhoicissus capensis (W)
Cyphostemma cirrhosum	R. digitata
Dalbergia armata (W)	R. rhomboidea (W)
D. obovata (W)	Secamone alpinii (W)
Embelia ruminata	Scutia myrtina (W)
Entada spicata (W)	Thunbergia dregeana
Flagellaria guineensis	Uvaria caffra

The secondary replacement of Coast Dune Forest by *Stenotaphrum* Grassland is discussed briefly in section 5.1.2 (B).

5.1.2 Hygrophilous Estuarine Vegetation

Hygrophilous vegetation found at the Tugela estuary does not differ greatly in its general characteristics from the fringing river vegetation further inland. The successional development in the brackish water and under the prevailing salt spray is, however, towards Estuarine Woodland and Coast Dune Forest, rather than to the Coast Lowlands Forest climax that occurs further inland.

In comparison with the soils found under Coast dune vegetation, those of the Estuarine Vegetation are less sandy and more compact, being derived from river alluvium. Locally these may be heavy and clayey, but all stages of admixture with dune sand and coarser river alluvia are found. Owing to their moistness, these soils are less mobile and more readily colonised by plants than are the dune sands. An important factor for the vegetation near the river is the considerable rise and fall of the river because of tidal influences, and because of floods and differences in winter and summer flows. During flood periods the hygrophilous zones nearest the river may be completely submerged and large portions of the vegetation washed out to sea, but extensive areas of sand banks are exposed during winter. During normal summer flows the *Phragmites* Reedswamp zone is generally in shallow water, while in winter the surface soil remains moist. On the south bank of the Tugela, the area between the first and second line of dunes is flooded when there is a combination of high spring tides and river floods. In this area the normal dune succession thus becomes interlocked with the hygrophilous vlei succession.

(A) REEDSWAMP COMMUNITIES

Phragmites communis and *Typha capensis* Reedswamp, up to 12 ft high, grows to within a few hundred yards of the ocean. Of the two species, *P. communis* is the more important, occurring in a zone up to one hundred yards wide along the banks of the Tugela. The community also occurs on the periodically inundated area behind the first line of sand dunes. Here, as a result of silting caused by windblown dune sand, the community is rapidly giving way to Sedge and Hygrophilous Grass Communities.

Typha Reedswamp occurs behind the first line of dunes in a small vlei, which is rapidly being filled by windblown dune sand.

In both the Reedswamp Communities, associated plants are sparsely represented. *Equisetum ramosissimum* and *Leersia hexandra* are occasional, while *Typha* may be present in *Phragmites* Reedswamp.

(B) SEDGE, RUSH AND HYGROPHILOUS GRASS COMMUNITIES

Sedge, Rush and Hygrophilous Grass Communities occur under vlei conditions in zones marginal to reedswamp. Sedge meadow is poorly developed, occurring only in narrow zones fringing the reedswamp. Grass communities are more extensive and represent more stable communities.

Scirpus littoralis occurs on bare sand or mud banks in open communities, 2 to 4 ft high.

On moist sandy soils, *Juncus maritimus* is dominant in a zone around *Typha* Reedswamp. Typical associated species include *Pycreus polystachyus*, *Cyperus natalensis*, *Fimbristylis obtusifolia*, *Kyllinga aurata*, *Mariscus dregeana* and *Bulbostylis collina*. As the general soil level is raised and the habitat becomes drier, largely by the accumulation of windblown sand, the community is invaded by *Passerina* Low Scrub (section 5.1.1.1 (C)).

Fimbristylis ferruginea forms a narrow ecotone on mud, fringing *Phragmites* Reedswamp. Associated species are chiefly the invaders, *Paspalum vaginatum*, *Stenotaphrum secundatum* and *Sporobolus virginicus*.

Although a co-dominant on sandy soils in *Passerina* Low Scrub, *Sporobolus virginicus* also forms a consocies on moist, brackish clay soils of the vlei hydrosere. Where the clay soils are covered by blown sand, the

community develops into *Passerina* Low Scrub. More commonly the *S. virginicus* Consocies is invaded by *Stenotaphrum secundatum.*

A dense community, usually about 6 ins high formed by the creeping rhizomatous grass, *Stenotaphrum secundatum*, is fairly extensive in rather moist areas subject to a certain amount of disturbance by grazing or trampling. It occurs on the moist and more compact soils derived from river alluvium, as well as on sandy dunes. In moister areas *Paspalum vaginatum* may be dominant.

Stenotaphrum secundatum also forms a short grassland along the fixed dunes facing the sea where Dune Scrub or Forest has been cleared or prevented from developing by secondary factors. Here, as well as to some extent in the hydrosere, the community may be regarded as a relatively stable secondary deflection of the prisere which, in the absence of grazing or trampling, is invaded by Dune Scrub.

(c) ESTUARINE WOODLAND

Fringing Estuarine Woodland occurs along the banks of the Tugela River. The community is dominated by *Hibiscus tiliaceus*, from 12 to 25 ft high, forming a much branched, relatively dense, single stratum of crooked boled, large leaved trees standing in shallow water. *H. tiliaceus* may invade *Phragmites* Reedswamp, but also develops upon bare mud banks.

No mangroves exist at present in the Tugela estuary, probably because siltation and the heavy floods prevent their establishment and because the old lagoon is no longer present.

5.1.3 Community Interrelations

The general interrelationships of the Coast Dune and Estuarine communities are shown in Fig. 14.

The stage of development reached by Coast Dune and Estuarine Vegetation is mainly dependent on the amount of windborne salt spray to which the various communities are exposed. When very close to the sea a considerable measure of stability may be found in some of the more spray tolerant seral stages such as *Brachylaena-Mimusops* and *Chrysanthemoides-Eugenia* Scrub. These communities are then composed of a dense mass of stunted, deformed individuals with a neatly 'clipped' canopy, gradually increasing in height away from the sea. They serve as salt-spray stabilised 'buffer zones' behind which Dune Forest is developed. Where there is some protection from wind-borne salt spray, such as on the inland sides of the dunes, Coast Dune Forest also shows a distinct tendency towards further development to Coast Lowlands Forest, which is the climax further inland away from the salt spray area.

Development of the estuarine hydrosere is toward a brackish water tolerant Estuarine Woodland, or to Coast Dune Forest where the soil surface is raised rapidly by wind-blown sand to an appreciable height above the water table. Further development of Estuarine Woodland would be to Streambank Forest if fresh water conditions were to develop.

5.2 Vegetation of Rock Outcrops and Shallow Soils

Coast vegetation characteristic of rock outcrops and shallow soils is found principally in the Coast Hinterland where, apart from the relatively even topography immediately along the catchment boundary, the ground slopes steeply down into the dry Valley Region. The rock outcrop and shallow soil vegetation occurs on cliffs and ledges, on rock outcrops and on shallow soils along the steep tributary streams and on the divides between streams.

Apart from the earliest stages, many xeroseral communities of the coast vegetation are dominated by woody plants. Trees and shrubs, for example *Ficus spp.* and more mesophytic forest precursors and forest initials (the first forest species, see section 5.5), enter early into the succession in cracks and soil pockets on cliffs, on boulders and on exposed rock strata. In the Coast Hinterland Region, early entry of woody plants is a result of the protection afforded from fire and from secondary disturbance by the rocky habitat. Where fire and disturbance—grazing, trampling, browsing, utilisation by man—operate in less protected habitats of the xerosere, xerophytic grasses (see Chapter 7) become dominant. They mark the beginning of the deflection of the xerosere by fire, by grazing or by both, to grassland. In the Coast Lowlands Region, deflection of the prisere to grassland does not commonly occur because of the entry of relatively fire resistant *Acacia* Scrub or Savanna vegetation, and because of the lessened effectiveness of fire due to the relatively ill-defined dry season in the Coast Lowlands climate (Chapter 2). Extensive grassland in the Coast Lowlands is thus seldom found except where it is maintained by man, or where poor soil drainage does not favour tree and shrub establishment.

(a) PIONEER CRYPTOGAMIC AND HERBACEOUS STAGES

Pioneer cryptogams and herbs occur on a variety of habitats ranging from the most xeric, dry, unbroken

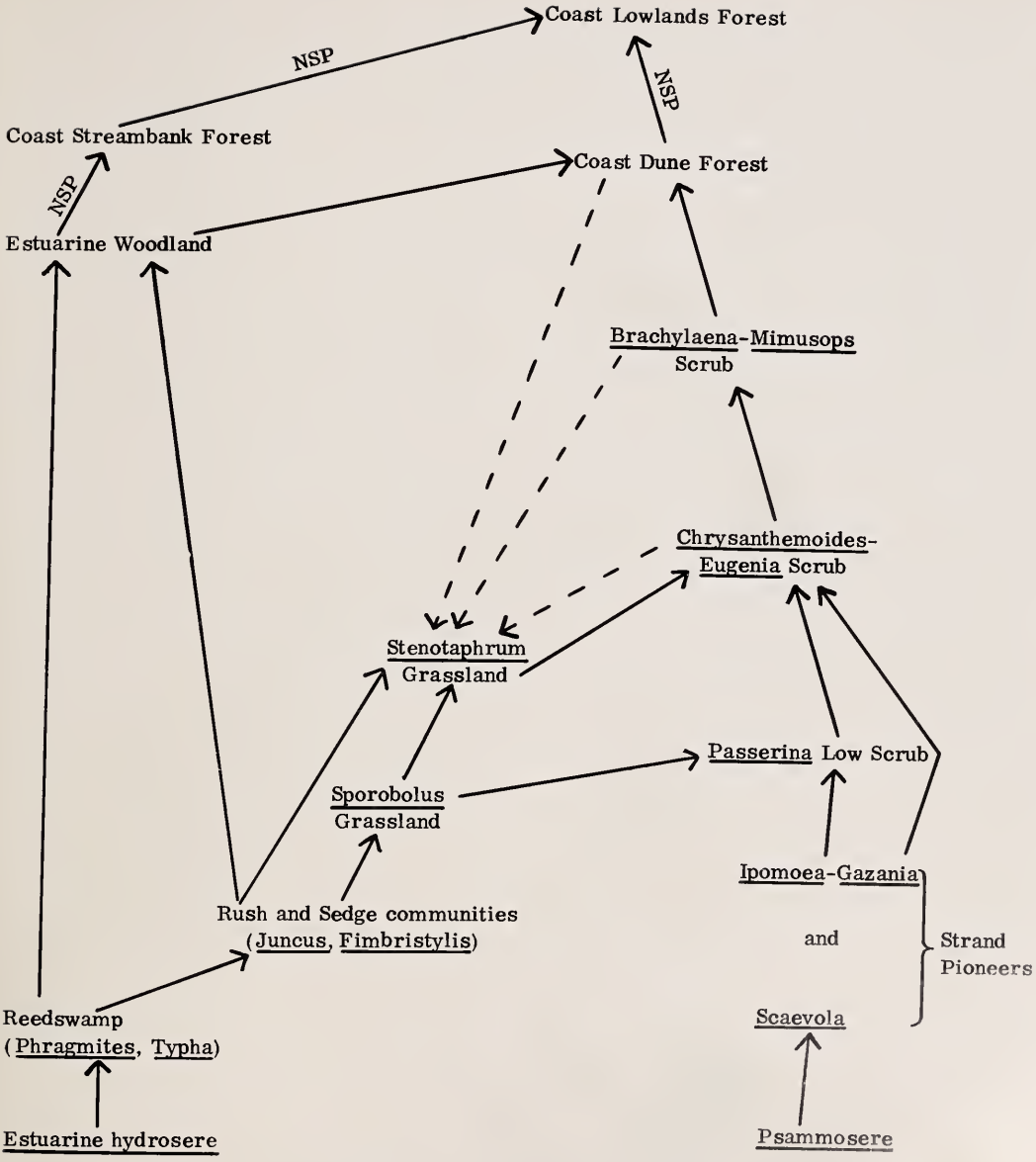


Fig. 14. General community interrelationships of Coast Dune and Estuarine vegetation

rock surfaces and crevices, to periodically or permanently moist surfaces and crevices. Lichens, mosses and compact mats, less than 6 ins high, of *Selaginella dregei* are amongst the most important plants on the most xeric rock surfaces. In crevices there is found a great variety of plants ranging from xerophytic ferns and herbs, such as *Cyanotis nodiflora*, to grasses, and to forest precursor shrubs and trees.

Small societies of low shrubs, 2 to 3 ft high, of *Euryops floribundus*, occur on some of the more exposed, wind-swept rocky summits and ridges of the Coast Hinterland Region, especially on Table Mountain sandstones. The plants grow typically in cracks in the underlying horizontal rock strata. As soil and organic material accumulate under the shrubs and the growth becomes denser, conditions become more favourable for the entry of fire, which eventually sweeps through the community. As a result, further development is then towards grassland (see Chapter 7).

(B) PIONEER TREE AND SHRUB COMMUNITIES

Amongst the most important pioneer tree and shrub communities on rock outcrops and shallow soils are those dominated by *Aloe arborescens*, *Ficus spp.* and *Buddleia saligna*.

Scrub communities dominated by *A. arborescens* occur through most of the Tugela Basin except the Mountain Region. They are also infrequent in the Coast Lowlands Region. The communities occur in rock crevices, on scree, and on very shallow, stony soils. The communities are composed of an open to dense mass of succulent shrubs, usually 5 to 6 ft in height, which are usually limited in extent by veld fires. Evidence of their seral relationship to forest in moist ecological regions is provided by the occurrence of seedling forest precursors and forest initials (see section 5.5) in the litter under the protection of the shrubs. The invading species eventually overtop and suppress the light-demanding succulents. But in the dry Valley Region the communities are relatively stable, seldom progressing beyond a semi-closed condition.

Open tree and shrub communities of *Ficus ingens* and *F. sonderi* exist mainly at warmer, lower levels of the Coast Hinterland and in the Valley Regions. Occasionally they occur in the Interior Basins Region, *F. ingens* extending up to 6,000 ft on warm rock faces in the upper Highlands Region. In the Coast Hinterland and marginal Valley areas, *F. sonderi* communities are commonly associated with *Combretum gueinzii* Tree Veld. The *Ficus* communities occur in rock crevices and in soil pockets on large boulders and on cliff faces, where germination of the bird distributed seeds can occur. Ultimately large roots are produced which extend through crevices and over the boulder and rock surfaces, often splitting the boulders into large fragments. Although frequently a much branched shrub closely appressed to rock surfaces, *F. ingens* also occurs as a tree 20 ft or more in height. *F. sonderi* is typically a tree, 15 to 25 ft high, reaching to over 30 ft high in moist and warm areas. In the Coast Hinterland Region, under the relatively dense shade cast by the trees, mesophytic forest precursors and forest initials grow in the deeper soil at the base of rocks or large boulders, and there is a successional development towards forest. Inland, away from the moist warm coast climates, successional development of the communities is less marked, and in the dry Valley and Interior Basins Regions they are relatively stable. Following the build-up of vegetation around the *Ficus* trees in moist regions, fire may enter and prevent the succession toward forest.

Communities dominated by *Buddleia saligna* occur on stony outcrops and on shallow soils, especially over dolerite, in the Coast Lowlands, Valley and Interior Basins Regions. They consist of a fairly open or relatively dense scrub from 8 to 15 ft high. In the Coast Lowlands, the communities are commonly associated with *Acacia nilotica* on rock outcrops and with shallow soils in Coast *Acacia karroo-A. nilotica-A. robusta* Thorn Scrub (section 5.3). Under the moist Coast Lowlands climate, forest precursors and forest initials may be frequent and indicative of successional relationship to the Coast Lowlands Forest climax.

In the Coast Lowlands Region, *Euphorbia triangularis* occasionally forms a succulent scrub, up to 25 ft high, on steep, rocky slopes and in kloofs, similar to that extensively developed in the Valley Region (Chapter 6). The coast communities differ from their Valley counterpart chiefly in their associated species, which are typically Coast Lowlands in character.

Greyia sutherlandii (see Chapter 8), a species common on rock outcrops in the Highlands Region, particularly in the Drakensberg foothills, grows sparsely on boulders and on south aspect scree-slopes in the Coast Hinterland Region.

(C) COMBRETUM GUEINZII TREE VELD

Deciduous communities of *Combretum gueinzii* are characteristic of stony shallow soils, especially on steep north-facing slopes below, in and above the ecotone between the Coast Hinterland Region and the Lower

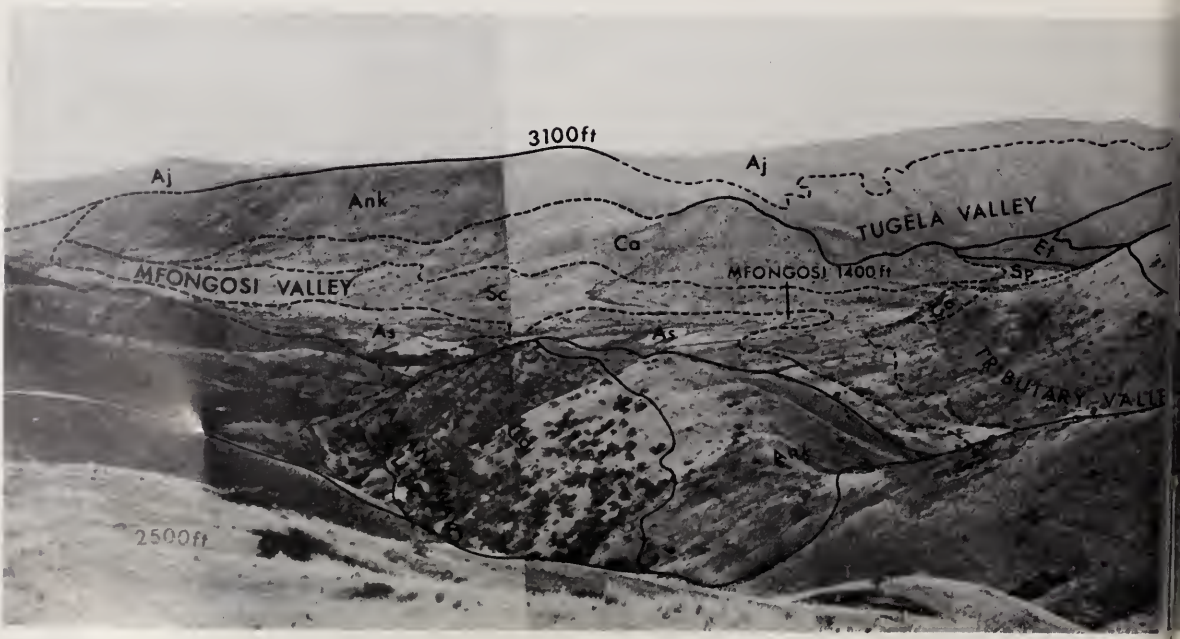

3100ft
Aj
Ank
Aj
TUGELA VALLEY
Ca
Ef
MFONGOSI VALLEY
Sc
MFONGOSI 1400ft
Sp
Ag
As
TRIBUTARY VALLEY
Ank
2500ft

Photo. 27. General view from upper Amanziwayo valley showing Valley Vegetation in Mfongosi area of Tugela Valley. The plant communities are distributed here mainly according to altitude, slope aspect, and soil depth.

Aj = Secondary *Aristida junciformis* Grassland, including scattered Semi-coast Forest Precursor Communities.
Ank = *Acacia nilotica-A.karroo* Thorn Veld of Marginal and Transitional Valley Vegetation.
As = *Acacia sieberiana* Tree Veld on flat, alluvial, intensively cultivated, tributary valley floors.
Ca = *Combretum apiculatum* Tree Veld on steep, north facing slopes and stony, shallow soils. (Detail in photo 40)
Er = Scattered *Erythrina latissima* Tree Veld of Marginal and Transitional Valley Vegetation.
Et = *Euphorbia tirucalli* Succulent Scrub, sparsely represented in narrow section of Tugela Valley.
Sc = *Sclerocarya birrea* Tree Veld on deeper soils of valley floors under drier conditions than As.
Ts-As = Moist Transitional *Acacia sieberiana* Scrub.
—— = Primary vegetation boundaries.
..... = Vegetation boundaries obscured by disturbance, cultivation, etc.

Valley Sub-region. The community thus occurs at the lower altitudes of the Semi-coast Bush Clump-Grassland Mosaic (section 5.3) and in Dry Coast *Acacia karroo-A. nilotica* Thorn Veld (Chapter 6). At its lowest altitudinal limits along the sides of the Valley Region, *C. gueinzii* Tree Veld grades into *C. apiculatum* Tree Veld of the Dry Valley Scrub and Savanna vegetation, as, for example, along the road from Kranskop to Middledrift.

In structure, *C. gueinzii* communities range from an open tree veld, to a fairly short scrub, and to a woodland in which the dominant trees are from 10 to 25 ft high (Photo. 9). At dry, lower altitudes, marginal to the Valley Region, open tree veld or open scrub forms are common, for example in the Insuzi River valley. Nearer the coast, and at higher altitudes where the climate is more moist, the community may occur as a woodland.

Because of its distribution in, and on either side of the ecotone between the Valley and Coast Hinterland Regions, subordinate species of *C. gueinzii* Tree Veld differ with the gradient from dry to moist climates. A number of different subordinate species also occur because of the complex topography. Associates of the dominant *Combretum gueinzii* thus consist of the more xerophytic species of Dry Coast *Acacia karroo-A. nilotica* Thorn Scrub (Chapter 6), of Mixed *Acacia caffra* Scrub (ibid.), and of the Semi-coast Bush Clump-Grassland Mosaic (section 5.5). In an open form of the Community developed in the cracks between large, barren rock slabs of the Insuzi Series between Qudeni and Nkandla, *Vellozia retinervis* is prominent in the field layer up to 3 ft high. The secondary grass, *Aristida junciformis*, is a consistent dominant up to 2·5 ft high in the field layer.

The successional relationships of *C. gueinzii* Tree Veld are to Semi-coast Forest in the Coast Hinterland Region and to ecotonal scrub-forest in the dry Coast Hinterland-Valley transition.

5.3 Coast Thorn Scrub and Grassland Vegetation

The most extensive plant communities of the coast vegetation are Coast *Acacia karroo-A. nilotica-A. robusta* Thorn Scrub, the Semi-coast Bush Clump-Grassland Mosaic and Semi-coast Secondary *Aristida junciformis* Grassland.

(a) Coast Acacia karroo-A.nilotica-A.robusta Thorn Scrub

Distribution and general ecology: Apart from the extensively planted sugar cane, Coast Thorn Scrub is the predominant vegetation of the Coast Lowlands Region. It extends to an altitude of 1,500 ft on either side of the Tugela River, giving way inland to the Semi-coast Bush Clump-Grassland Mosaic at higher altitudes, and to Dry Coast *Acacia karroo-A. nilotica* Thorn Veld of the Valley Region (Map 1).

Mean annual rainfall in the Coast Lowlands is between 1,000 mm. and 1,250 mm.; frosts are absent or light locally (Chapter 2). Soils are partly leached types derived from Dwyka and Ecca Series, or locally from Table Mountain sandstones (Chapter 3).

Physiognomy and structure: Although consisting of a number of species that are deciduous further inland, for example the *Acacia spp.*, in Coast Thorn Scrub these species remain green throughout the year or lose their leaves for one to two months during a particularly dry winter season.

Because of secondary influences which maintain the community, there is considerable variation in structure and physiognomy. It is mainly a fairly dense scrub with numerous thickets and bush clumps (Photo. 10) in which forest precursors and forest initials are found (see section 5.5 and following). Open tree veld forms are not common. There are four main strata.

(a) A tall tree layer, usually over 20 to 25 ft high, discontinuous, and confined mainly to the centres of bush clumps.
(b) A short tree layer from 10 to 18 ft high, showing various degrees of closure, provides the main upper tree stratum.
(c) A shrub or small tree layer up to 8 ft high.
(d) A field layer, dependent on the density and type of tree and shrub layers present, is either a heliophilous grass or shade tolerant mixed grass-herbaceous layer.

In addition to the tree, shrub and herbaceous strata there are:

(e) Numerous climbers, and
(f) Occasional angiosperm epiphytes and parasites.

Composition: Of the three heliophilous dominants characterising the community, *A. karroo* is invariably present, *A. nilotica* is more important on shallower soils and on drier and hotter slopes, and *A. robusta* may be absent where secondary disturbance is marked. *A. karroo* and *A. nilotica* are dominants in the short tree stratum, while *A. robusta* is dominant in the discontinuous tall tree layer.

Forest precursors, representing heliophilous [illegible] successionally closely related to climax forest [illegible] initials, which are shade tolerant and the [illegible]

species appearing in the succession, may be found occasionally to frequently in bush clumps and where there is protection from disturbance. Although successionally important, precursors and initials are, nevertheless, essentially of local importance only in the Coast Thorn Scrub of the Tugela Basin.

Typical species of the discontinuous tall tree layer include (FP = Forest precursors; FI = Forest initials; see also section 5.5):

Acacia robusta	Sideroxylon inerme
Euphorbia ingens	Ziziphus mucronata
Cussonia spicata (FP)	Schotia brachypetala
Acacia sieberiana (FP)	Phyllogeiton zeyheri
Sclerocarya birrea	

Occasional to frequent species are:

Ficus natalensis (FI)	Ekebergia capensis (FI)
F. petersii (FI)	Harpephyllum caffrum (FI)
Trichilia emetica (FI)	Maytenus peduncularis (FI)
Albizia adianthifolia (FP)	Minusops obovata (FP)
Trema orientalis (FP)	Millettia grandis (FI)
Rhus legatii (FI)	Erythroxylum pictum (FP)
Apodytes dimidiata (FI)	Protorhus longifolia (FI)
Chaetacme aristata (FI)	Croton sylvaticus (FI)
Celtis africana (FI)	Syzygium cordatum (moist situations)
	Ficus capensis (moist situations)

Syzygium cordatum and *Ficus capensis* are not confined to streambanks as they are further inland.

Typical species of the main, short tree layer are:

Acacia karroo	Euclea natalensis (FP)
A. nilotica	Cussonia kraussii (FP)
A. gerrardii	Rhus pentheri
A. caffra	Hippobromus pauciflorus (FP)
Dichrostachys cinerea	
Canthium inerme (FP)	Kraussia floribunda (FP)
Vangueria infausta	Heteropyxis natalensis
Erythrina lysistemon (FP)	Psidium guajava (exotic)
Clerodendrum glabrum (FP)	Diospyros cordata (FP)
	Scolopia zeyheri (FP)
Turraea floribunda (FP)	Cordia caffra (FP)

Under a denser canopy in bush clumps and on mesoclines, the forest precursors and forest initials, *Clausena anisata*, *Allophylus melanocarpus*, *Fagara capensis*, *Rothmannia globosa* and *Trimeria grandifolia* are found.

Typical species of the shrub and small tree layer include:

Pavetta lanceolata (FP)	Lippia javanica
Maytenus senegalensis	Lantana rugosa
M. cymosus	Rhus simii
M. undatus	R. dentata
Grewia occidentalis (FP)	Leonotis leonurus (FP)
Putterlickia verrucosa	Ximenia caffra
Ehretia rigida	Eugenia sp. (DE 1863, 1921)
Xeromphis rudis (in shade)	Acokanthera oppositifolia
	Pavetta gracilifolia
Diospyros lycioides	P. khomghensis
D. glandulifera	Carissa macrocarpa (FP)
D. dichrophylla	Erythrina humeana

Under a denser canopy on mesoclines and on moister situations, *Phoenix reclinata* (FP), *Strelitzia nicolai* (FP), *Calpurnia subdecandra*, *Dovyalis rhamnoides* (FI) and *Erythrococca natalensis* may be found.

Climbers are numerous, especially in bush clumps. Species with relatively thick, heavy, woody stems contributing considerably to the density of the vegetation, include:

Jasminum spp.	Popowia caffra (FI)
Scutia myrtina (FP)	Uvaria caffra (FI)
Acacia kraussiana (FP)	Rhoicissus rhomboidea (FP)
A. ataxacantha (FP)	
Entada spicata (FP)	R. tridentata (FP)
E. wahlbergii	R. capensis (FP)
Capparis tomentosa	Cnestis natalensis (FI)
Clematis brachiata (FP)	Acridocarpus natalitius
Dalbergia obovata (FP)	Diospyros simii
D. armata (FP)	D. villosa

Semi-woody and herbaceous climbers include:

Cissampelos torulosa (FP)	Smilax kraussiana (FP) and many others
Dalechampia volubilis	
Microglossa mespilifolia	

Succulent and semi-succulent climbers are less frequent. They include:

Sarcostemma viminale	Cissus fragilis
Senecio pleistocephalus	C. spp.
Cyphostemma spp.	

Under a light canopy and where the tree and shrub layers are open, bunch grasses are dominant in the field layer. This field layer, up to 5 ft high, is more scrubby, coarser and ranker than in grasslands of the interior Tugela Basin. In parts of the Coast Lowlands Region, where woody plants have been cleared, the grassland is rapidly invaded by trees and shrubs to form the Coast Thorn Scrub. Species found in the grass field layer include:

Themeda triandra	Perotis patens
Aristida junciformis	Bothriochloa insculpta
Digitaria macroglossa	Hyparrhenia spp.
Tristachya hispida	Cymbopogon validus
Setaria sphacelata	C. excavatus
Eragrostis curvula	Pteridium aquilinum
E. plana	Lasiosiphon sp.
Sporobolus capensis	Waltheria indica
Rhynchelytrum repens	Pentanisia prunelloides
Allopteropsis semialata	Wedelia natalensis
Elyonurus argenteus	Aloe saponaria
Chloris gayana	and many others

On shallow soils, *Eragrostis capensis*, *E. racemosa* and *Rhynchelytrum setifolia* are common. *Stenotaphrum secundatum* and *Pennisetum clandestinum* (introduced) are dominant in moist areas.

Above 750 ft altitude, the secondary species, *Aristida junciformis*, is dominant.

Under dense tree and shrub layers there is a considerable diversity of field layer species. Typical shade grasses

are *Panicum maximum*, *P. aequinerve*, *Dactyloctenium australe*, *Setaria chevalieri* and *Oplismenus hirtellus*. Other plants include *Cyperus albostriatus*, *Asparagus spp.*, *Commelina africana*, *Aneilema dregeanum*, *Hypoestes verticillaris*, *Justicia flava* and other species, including ferns and Acanthaceae.

Parasitic plants occasionally found on trees and shrubs include *Loranthus dregei* and *L. spp.*, and on grass roots, *Harveya speciosa*. Angiosperm epiphytes occasionally found include *Mystacidium spp.*

Discussion: Coast *A. karroo-A. robusta-A. nilotica* Thorn Scrub represents a stage in the succession to Coast Lowlands Forest and is maintained by secondary factors in the form of fire, grazing, browsing and the felling of trees for timber, firewood and other purposes. The exploitation of timber from the larger forest species, which would form the upper, dominant canopy layer, is an important factor restricting forest development. Evidence of the subclimax relationship of the Thorn Scrub is provided by the abundant bush clumps, showing all stages of development to Coast Lowlands Forest (Photos. 11–14), and by forest and scrub-forest in less accessible and better protected areas unsuitable for grazing or the cultivation of sugar cane.

(B) SEMI-COAST BUSH CLUMP-GRASSLAND MOSAIC

Distribution and general ecology: This occurs at the lower, warmer, less misty altitudes of the eastern part of the Coast Hinterland Region. It extends eastwards from 1,500 ft up to 2,500 ft altitude at Mapumulo and Mbongolwane on either side of the Valley Region (see Map 1). Outlying traces of the community may be found as far west as Kranskop and Qudeni. It covers approximately 90 square miles, or 0·8% of the Tugela Basin.

Mean annual rainfall is from 800 mm. to 1,250 mm.; frosts are absent or light (Chapter 2). The community is developed mainly on shallow sandy soils derived from the Table Mountain series, but occurs also on deep soils derived from Archaean Granite.

Physiognomy and structure: The Semi-coast Bush Clump-Grassland Mosaic is composed typically of bush clumps, 15 to 30 ft high and about 30 ft in diameter, often on termitaria or small rock outcrops scattered at various distances in a secondary grassland dominated by *Aristida junciformis* (Photos. 15 and 16). Forest precursors and forest initials are frequent to abundant in the bush clumps. Variations in structure and physiognomy are due to the typical bush clump character having been greatly modified through the influence of heavy populations of Bantu (see Chapter 4). The separation of the Semi-coast Bush Clump-Grassland Mosaic from Dry Coast *Acacia karroo-A. nilotica* Thorn Scrub (Chapter 6) of the marginal Valley Region vegetation is often obscured by *Acacia* and *Dichrostachys* thicket and scrub development, especially at the lower altitudes. Complete clearance of woody vegetation and its replacement by grassland obscures separation from Semi-coast Secondary *Aristida junciformis* Grassland (see (D)), dominant at higher altitudes in the Coast Hinterland Region.

Composition: Acacia spp. play a smaller rôle than in the allied Coast Thorn Scrub (see (A)) and forest precursors and forest initials are more important in the Semi-coast Bush Clump-Grassland Mosaic. Of the taller tree species over 15 ft high, abundant to frequent species of general occurrence include (FP = Forest precursors; FI = Forest initials, see (A) and also section 5.5):

Cussonia spicata (FP)	Ekebergia capensis (FI)
Ficus petersii (FI)	Harpephyllum caffrum (FI)
F. natalensis (FI)	Protorhus longifolia (FI)
Sideroxylon inerme	Syzygium cordatum
Ziziphus mucronata	Ficus capensis (FI)
Acacia sieberiana (FP)	Trema orientalis (FP)
A. karroo	Celtis africana (FI)
A. nilotica	Rhus legatii (FI)
A. gerrardii	Trichilia emetica (FP)
A. caffra	Chaetacme aristata (FI)
Erythrina lysistemon (FP)	Croton sylvaticus (FI)
E. latissima (FP)	Turraea floribunda
Apodytes dimidiata (FI)	Sclerocarya birrea
Albizia adianthifolia (FP)	Rhus rehmanniana (FP)

Occasional or local species include:

Nuxia floribunda (FI)	Olea capensis ssp. enervis
Heeria paniculosa	Erythroxylum pictum (FP)
Ficus sonderi	Halleria lucida (FI)
Strychnos spinosa	Rapanea melanophloeos (FI)
S. innocua	Tarchonanthus trilobus
Combretum gueinzii	Bequaertiodendron natalense (FI)
Xylotheca kraussiana	
Phyllogeiton zeyheri	

Frequent to abundant shrubs or small trees to 12 ft high include:

Pavetta lanceolata (FP)	Grewia occidentalis (FP)
Canthium inerme (FP)	Putterlickia verrucosa
Clerodendrum glabrum (FP)	Heteropyxis natalensis
Canthium ciliatum (FI)	Xeromphis rudis
Vangueria infausta	Solanum mauritianum (introduced) (FP)
Leonotus leonurus (FP)	Hippobromus pauciflorus (FP)
Dichrostachys cinerea	Clausena anisata (FI)
Cestrum laevigatum (introduced) (FP)	Clutia spp. (FP)
Tecomaria capensis	Maytenus undata
Ehretia rigida	Lantana rugosa
Trimeria grandifolia (FI)	

Occasional or local species include:

Maesa lanceolata (FP)	Tricalysia lanceolata (FP)
M. alnifolia (FP)	Diospyros dichrophylla
Scolopia zeyheri (FP)	Dovyalis caffra
Caesalpinia decapetala (introduced)	Carissa bispinosa (FP)
Maytenus senegalensis	Brachylaena elliptica
Chrysanthemoides monilifera	

Climbers include:

Dalbergia obovata (FP)	Clematis brachiata (FP)
D. armata (FP)	Popowia caffra (FI)
Acacia ataxacantha (FP)	Smilax kraussiana (FP)
Rhoicissus tridentata (FP)	Cissampelos torulosa (FP)
R. capensis (FP)	Cissus fragilis
Tecomaria capensis	C. spp.
Diospyros villosa	Cyphostemma spp.

The heliophilous bunch grass field layer between the bush clumps is the Semi-coast Mixed *Themeda* Grassland, or the Semi-coast Secondary *Aristida junciformis* Grassland (see (C), (D)). The shade tolerant field layer in bush clumps is generally sparse and poorly developed because of grazing and trampling. Acanthaceae *spp.*, *Asparagus spp.*, *Commelina africana*, xerophytic ferns, *Cyperus albostriatus* and *Oplismenus hirtellus* may be found.

Discussion: Due to fire and other disturbance, the Semi-coast Bush Clump-Grassland Mosaic is a subclimax to Semi-coast Forest. In the Mapumulo district (Chapter 4), Bantu influences are very marked. Bush clumps are fast disappearing, giving rise to a secondary *Aristida junciformis* grassland at higher altitudes, and at lower altitudes to scrub vegetation from the invasion of Valley Region species such as *Acacia nilotica*, *A. karroo*, *Dichrostachys cinerea*, *Euphorbia tirucalli* and *Diospyros dichrophylla*.

There is considerable evidence that much, if not all, the area now covered by the Semi-coast Bush-Clump Grassland Mosaic was once Semi-coast Forest (see Photos. 24–26). Many of the present bush clumps have developed around forest relics by an aggregation of forest precursor species and the entry of more xerophytic species. They also represent a forest precursor development around more xerophytic woody invaders, such as *Acacia sieberiana*, established on sites such as termitaria, where their saplings enjoy a certain degree of protection from fire. Although fire and disturbance are obvious factors affecting the development of the bush clumps, it is not yet understood why the bush clump character is so strongly developed.

(C) SEMI-COAST MIXED THEMEDA GRASSLAND

(D) SEMI-COAST SECONDARY ARISTIDA JUNCIFORMIS GRASSLAND

These grasslands are discussed in Chapter 7. It should be noted here that Semi-coast Mixed *Themeda* Grassland in the Coast Hinterland Region has been replaced by Secondary *Aristida junciformis* Grassland.

(E) SECONDARY THICKET COMMUNITIES

Secondary thicket communities are formed by *Acacia karroo*, *A. nilotica* and *Dichrostachys cinerea* in the Coast Lowlands Region and at the lower altitudes of the Coast Hinterland Region. These species are initial woody invaders on secondary areas, such as old cultivation. The communities are dense, scarcely penetrable, and almost invariably in stands of a single species. In these stands, plants are of even age and height. The thickets may persist and, in this way, many tall, closed *Acacia karroo* Woodlands from 15 to 30 ft high have developed on old lands. Thicket communities of the Coast Lowlands Region differ from their dry Valley Region counterparts in that forest precursors and forest initials may invade at an early stage in the secondary succession, but, even under the favourable climatic conditions of the Coast Lowlands Region, the thickets are remarkably persistent.

The introduced *Caesalpinia decapetala*, is frequently planted as a hedge around kraals in the Coast Hinterland Region and in the marginal Lower Valley Subregion. It spreads on disturbed areas and along dongas, forming small, dense, impenetrable, thorny thickets up to 10 ft high. Although relatively localised at present, the thickets are spreading and, under continued veld mismanagement, will prove difficult to control. There is also a spread of the introduced Black Wattle, *Acacia mearnsii*, on disturbed areas in the Coast Hinterland Region.

5.4 Hygrophilous Vegetation

Early stages in the hydrosere are only briefly referred to here, and have not been studied in any detail. The early seral hygrophilous communities are similar throughout the Tugela Basin, except in the Mountain Region.

The development of the hydrosere is in several respects analagous to that of the xerosere (section 5.2). The streambank habitat with its moist, and often rocky, character provides partial to complete protection against fire. Trees and shrubs enter early into the succession without necessarily following upon a sequence of earlier stages, such as reedswamp, rush and sedge

communities. Further development of the initial open streambank tree and shrub communities to closed forms is, in the Coast Hinterland Region especially, dependent on the degree of natural protection from fire and disturbance. Where protection is relatively small and the effects of fire and disturbance are marked, the community remains open. Where these are absent or limited in amount, the community becomes closed by the entry of forest precursors and forest initials (section 5.5), forming a scrub-forest (section 5.5) and then a streambank forest (section 5.6).

In the Coast Lowlands Region, where the plant succession is more rapid than in the Coast Hinterland Region, fire is less evident as a retarding influence. The soils are often deep and alluvial, open streambank communities being seldom found. Where open communities do occur, secondary influences are very marked.

On streambanks not protected from fire and other disturbing factors there is, as in the xerosere, (see 5.2), a deflection of the succession to grassland.

Vlei communities of the Coast Hinterland Region and further inland generally develop to grassland rather than to forest under present-day conditions. Initially, protection from fire is due to a high soil moisture. As the level is raised by silting and organic accumulation, the soil becomes drier, fires become more frequent, fire-tolerant sedge meadow replaces the reedswamp and is, in turn, replaced by hygrophilous grassland and then ultimately by mesophytic grassland (see Chapter 7).

(A) REEDSWAMP COMMUNITIES

Phragmites Reedswamp is common along permanent rivers and in vleis in the Coast regions. Along steeply flowing rivers in the upper Coast Hinterland Region however, the community occurs only locally on marshy protected situations. Reedswamp is thus not a typical early seral stage in these areas. Veld fires which burn right on to streambanks prevent development of *Phragmites* Reedswamp.

Typha capensis Reedswamp occurs locally in vleis.

Communities dominated by *Cyperus latifolius* and *C. immensus* resemble *Phragmites* and *Typha* Reedswamp in structure and habitat, but the *Cyperus* communities are almost entirely confined to vleis and marshy areas at the heads of streams. The *Cyperus* communities form pure stands, from 3 to 5 ft high, with few associated species.

(B) OPEN STREAMBANK TREE AND SHRUB COMMUNITIES

Streambank tree and shrub communities may occur as isolated, scattered trees and shrubs, as woodland (see (C)), or as Streambank Forest (see section 5.6). The initial, or Open Streambank Tree and Shrub Communities described here, are characteristic of streambanks in the Coast Hinterland Region, but not in the Coast Lowlands Region.

Typical streambank trees and shrubs in Coast vegetation are *Rauvolfia caffra*, *Ilex mitis*, *Salix woodii*, *Cliffortia spp.*, *Ficus capensis*, *Syzygium cordatum* and *S. guineense*. Typical Coast Lowlands streambank species are *Bridelia micrantha*, *Macaranga capensis*, *Ficus sycamorus*, *F. capraefolia* and *Combretum erythrophyllum*. In the Coast Hinterland Region as well as in the Uplands Regions, the tree-fern *Cyathea dregei* is a common, and *C. capensis* an occasional (in forest) streambank species.

Other species, which are really forest precursors and forest initials (see section 5.5), but occur commonly on streambanks in the coast regions, are *Trichilia emetica*, *Nuxia floribunda*, *N. congesta*, *Pittosporum viridiflorum*, *Rhus legatii*, *Halleria lucida*, *Burchellia bubalina*, *Protorhus longifolia*, *Ficus natalensis* and *Trema orientalis*. Similar forest precursor and common species along streambanks of the Coast Lowlands Region are *Phoenix reclinata*, *Strelitzia nicolai*, *Acacia robusta*, *A. karroo* and *Mimusops obovata* (Photo. 20). The shrub *Maesa lanceolata* occurs mainly in the Coast Hinterland Region.

(C) SWAMP WOODLAND AND SWAMP FOREST

Both these communities are of limited extent in the lower Coast Hinterland and Coast Lowlands Regions, representing depauperate versions of those found further north in Zululand.

Swamp Woodland, composed of trees 15 to 30 ft high, with a light canopy, the crowns of the trees barely touching, and a fairly well developed field layer mainly of sedges, occurs in vleis and along streams in the lower Coast Hinterland Region. The principal tree is *Syzygium cordatum*, with *Voacanga thouarsii* and *Ficus capensis* as occasional associates.

Near the sea along streams in the Coast Lowlands Region north of the Tugela River, local patches of Swamp Forest, 15 to 25 ft high, have been noted, but not examined in detail. The principal tree species recorded were *Syzygium cordatum*, *Voacanga thouarsii*, *Macaranga capensis*, *Rauvolfia caffra*, *Ficus* sp., *F. hippopotami* (?) and *Barringtonia racemosa*.

5.5 Forest Precursors and Forest Initials

Communities and species termed forest precursors

forest initials are characteristic of late successional stages leading to the development of forest. Relatively early stages are scrub communities composed of various heliophilous forest precursors. Later, the scrub develops into scrub-forest (see (F)), and then into Subclimax Forest (see (F)), by the invasion of the more shade tolerant and mesophytic initial forest species, heliophilous forest precursor scrub species being shaded out under the forest canopy.

Precursor and initial forest communities occur where there is protection from fire and disturbance and on expanding forest margins. Their development is prevented by fire, by secondary factors and, often, because of the limitations imposed on soil formation by steep topography.

Precursor, initial and subclimax forest communities have been variously designed by terms reflecting their habitat relationship. Precursor and initial forest communities have been called 'Small Scattered Bushes and Rocky Stream Bush', 'Rocky Hillside Formation of High Veld' (Bews, 1913); 'Gully Scrub and Hillside Bush' (Bayer, 1938); whereas Subclimax Forest has been called 'Krantz Forest' (Rycroft, 1942), 'Kloof Forest' (Killick, 1959; Wells, 1960) and 'Gully Forest' (Wells, 1960). Differences between these communities at comparable successional stages are due mainly to species typical of their hydrosere and xerosere development, for example *Rauvolfia caffra*, *Ilex mitis*, *Syzygium cordatum* and *Ficus capensis* on streambanks, and *Aloe arborescens*, *Cussonia spicata* and *Commiphora caryaefolia* on rock outcrops, on talus slopes and on steep topography. Apart from these hydroseral and xeroseral species, the communities resemble each other in having forest precursor species in earlier seral stages, and in having forest initials, in the later seral stages. The dominance of forest precursors and initials indicates the successional convergence of the hydrosere and xerosere to climax forest. The various communities have thus all been considered together here. Individual communities in the different habitats are referred to as Streambank Scrub, Streambank Scrub-Forest, Streambank Forest, Precursor Scrub, Scrub-forest and Subclimax Forest, or Subclimax Kloof and Gully Forest.

Some of the forest precursor and initial communities are clearly defined, but most are ill-defined scrub and scrub-forest communities. In the Coast Lowlands Region, precursor and initial forest species in the Coast *Acacia karroo-A. nilotica-A. robusta* Thorn Scrub have already been referred to (see section 5.3). In the predominantly grassland areas of the Coast Hinterland Region above 2,500 ft altitude, precursor and initial forest communities are more localised than at lower altitudes, occurring mainly where there is some protection from fire and disturbance.

(A) BRACKEN VELD

Communities of the Bracken Fern, *Pteridium aquilinum*, occur near sea level to over 7,000 ft altitude throughout the high rainfall regions of the Tugela Basin. They occur on forest margins and on moister soils in grassland, but also on rather drier soils, especially where the grass cover has been reduced by disturbance.

The communities are generally from 1 to 4 ft in height, with a relatively dense cover of the dominant species. Where the communities are burnt annually or biennially, and grazed (not the Bracken itself), there are relatively few associated species apart from grasses. Where there is some protection from fire and grazing or trampling, herbs, tall grasses, forest margin and forest precursor species become abundant, eventually suppressing the bracken.

(B) STICHERUS CONSOCIES

Pure, dense, consocies of the fern, *S. umbraculiferus*, 1 to 4 ft high, occur on protected, usually steep seepage areas adjacent to forests in the Coast Hinterland and Uplands Regions. The communities are able to withstand burning at long intervals, but when this is more frequent they are destroyed.

(C) CYMBOPOGON-MISCANTHIDIUM AND HYPARRHENIA TALL GRASS COMMUNITIES

Described in Chapter 7.

(D) FYNBOS COMMUNITIES

Small Fynbos Communities, which are outliers from the Uplands and Mountain Regions, occur above 2,500 ft in the Coast Hinterland. In protected situations on forest margins, *Erica natalitia* forms a shrub community up to 6 ft high. *Stoebe vulgaris* is also a fairly common fynbos species, forming small shrub communities up to 4 ft high on forest margins in misty areas. Open, short savanna communities, up to 5 ft high, of *Protea gaguedi* and *P. multibracteata* occur on shallow stony soils above the Insuzi River and near the Kop at Kranskop.

The Fynbos communities, are considerably affected by fires and are generally absent where these are frequent.

(E) FOREST MARGIN AND PRECURSOR SCRUB

In addition to the relatively well defined forest precursor

communities described in the preceding, there occur on forest margins, on rock outcrops and on streambanks, a number of scrub communities of very varied composition and structure. Generally there is no clear species dominance.

The species constituting the communities are almost all heliophytes, but the most shade tolerant, such as *Cassinopsis ilicifolia*, *Clausena anisata* and *Allophylus melanocarpus*, occur frequently in forest. These species, nevertheless, appear relatively early in the forest succession.

Where precursors are found in forest, it is mainly under a light canopy due to steep topography, shallow soils, where a large tree has fallen and opened the canopy, or to secondary factors. Many forest precursors appear in late successional stages or climax communities of the vegetation in the Valley Region, and are generally dominant in the climax communities of the transition areas between the Coast Regions and the Valley Region.

Forest Precursor Scrub may be from 4 to 20 ft high. Scrub is tall chiefly on streambanks and in kloofs. Further development of Forest Precursor Scrub is to a scrub-forest and short forest in which the initial forest species become dominant (see (F)).

The principal forest precursor trees are shrubby or relatively low growing, from 6 to 20 ft high. The more xerophytic species, occurring in earlier seral stages, are (L = Lower altitudes of Coast Hinterland Region):

Rhus rehmanniana	Pachystigma macrocalyx
R. pyroides	Acacia sieberiana (L)
Canthium mundtianum	A. karroo (L)
Buddleia salviifolia	Greyia sutherlandii
Hippobromus pauciflorus	Maytenus cymosus (forma)
Cussonia spicata	Erythrina lysistemon (L)
Clerodendrum glabrum	E. latissima (L)
Canthium inerme	

The more mesophytic and shade tolerant species typical of later seral stages are:

Allophylus melanocarpus	Albizia adianthifolia (L)*
Heteromorpha trifoliata	Alberta magna
Clausena anisata	Smodingium argutum
Maytenus acuminatus	Chaetacme aristata (L)*
Erythroxylum pictum	Dais cotinifolia
Duvernoia adhatodioides	Scolopia zeyheri*
Trema orientalis	Teclea natalensis
Burchellia bubalina	Commiphora caryaefolia
Cunonia capensis	

* Trees, which in forest may exceed 40 ft. in height.

Typical shrubs and suffrutices, from 3 to 10 ft high, are:

Anastrabe integerrima	Grewia occidentalis
Carissa bispinosa	Acacia ataxacantha
Cassinopsis ilicifolia	Solanum mauritianum (introduced)
Maesa lanceolata	Rubus rigidus (introduced)
M. alnifolia	
Rhus dentata var. grandifolia	Aloe arborescens
Pavetta lanceolata	Erica natalitia
Polygala virgata	Syncolostemon rotundifolius
Clutia galpinii	Schistostephium rotundifolium
C. glabrescens	Selago longipedicellata
Rhamnus prinoides	Stoebe vulgaris
Leonotis leonurus	Myrica pilulifera
Cestrum laevigatum (introduced)	Euryops floribunda
	Calpurnia subdecandra

The ferns, *Cyathea dregei* (streambanks), *Pteridium aquilinum* and *Sticherus umbraculiferus*, are also common on forest margins or in Forest Precursor Scrub.

Typical grasses are *Trichopteryx dregeana* (locally), and the tall grasses, *Miscanthidium capensis*, *Cymbopogon excavatus*, *C. validus*, *Hyparrhenia aucta* and *H. cymbaria*.

Climbers are common, especially herbaceous and semi-woody species. They include:

Canthium gueinzii	Entada spicata
Dalbergia obovata	Acridocarpus natalitius
D. armata	Uvaria caffra
Rhoicissus rhomboidea	Helinus integrifolius
R. tridentata	Scutia myrtina
Clematis brachiata	Smilax kraussiana
Cissampelos torulosa	Behnia reticulata
Senecio tamoides	Dioscorea spp.
S. macroglossa	Potamophila prehensilis
Buddleia pulchella	Coccinia palmata
B. auriculata	Ceratiosicyos laevis
Cassinopsis ilicifolia	Riocreuxia torulosa
Acacia ataxacantha	Secamone alpinii
A. kraussiana	S. gerrardii

In addition to their importance in the primary succession, forest precursor species are also important in secondary successions arising from forest destruction. Some species, such as *Duvernoia adhatodioides* and *Solanum auriculatum*, may become particularly prominent in secondary forest.

(F) FOREST INITIALS, SCRUB-FOREST AND SUB-CLIMAX FOREST

As already defined, forest initials are the initial forest species which invade the various precursor communities. They are nearly all important constituents of climax forest. All the species are shade tolerant in their seedling and sapling stages.

Scrub-forest is a seral stage in which forest initials occur together with forest precursor species. This community is from 15 to 30 ft high, consisting essentially of 'emergent' trees of forest initials and tall forest precursors, a dense short tree and shrub layer from 4 to 10 ft high, a sparse field layer and [illegible] climbers.

Subclimax Forest represents an immature [illegible]

from 30 to 60 ft high, in which forest initials are dominant. There are also present the more mesophytic forest precursors and typical forest species. Fewer species are found, structural features are less well defined and climbers are more numerous than for Climax Forest, described in section 5.6.

Subclimax Forest represents the most common forest type in the Tugela Basin, occurring typically in small patches in kloofs, along streambanks, below cliffs and on scree slopes. Its prevalence is due either to unfavourable topographic, climatic or edaphic factors or, more commonly, to secondary factors. These Subclimax Forests have been variously termed Krantz Forest (Rycroft, 1943), Kloof Forest (Killick, 1959; Wells, 1960) and Gully Forest (Wells, 1960).

The principal forest tree initials are:

Rapanea melanophloeos	Maytenus peduncularis
Apodytes dimidiata	Ficus natalensis
Combretum kraussii	F. petersii
Halleria lucida	Diospyros whyteana
Protorhus longifolia	Trimeria grandifolia
Croton sylvaticus	Gardenia neuberia
Ekebergia capensis	Rothmannia globosa
Harpephyllum caffrum	Pittosporum viridiflorum
Trichilia emetica	Scolopia mundtii
Kiggelaria africana	Cassinopsis tinifolia
Celtis africana	Ptaeroxylon obliquum
Nuxia congesta	Cryptocarya woodii
N. floribunda	Vepris undulata
Rhus legatii	Seemannaralia gerrardii
Bequaertiodendron natalense	Calodendrum capense

On streambanks, the principal forest tree initials are *Ilex mitis* and *Ficus capensis*.

Shrubs which are forest initials include:

Maytenus mossambicensis	Dovyalis rhamnoides
Canthium ciliatum	Dracaena hookeriana

Climbers are relatively few, and include *Cnestis natalensis*, *Popowia caffra*, *Cassine tetragona* var. *laxa* and *Strophanthus speciosus*.

Typical field layer forest initials have not been determined.

A feature to be noted here is the absence of *Podocarpus latifolius* as a forest initial in the Coast Regions. In the Uplands Regions, especially in the Highlands Region along the lower slopes of the High Drakensberg, it is an abundant forest initial. This coincides with the minor rôle played by *Podocarpus spp.* in the Coast Forests (section 5.6).

5.6 The Coast Forests

Forests of the coast regions are distinguished from the Uplands Forests (Chapter 8) by the presence of *Protorhus longifolia*, *Croton sylvaticus*, *Trichilia emetica* and other Coast species; a more abundant and more mixed species composition; the very minor rôle played by *Podocarpus spp.*; and generally larger leaf sizes.

Apart from Nkandla, which is amongst the largest of the forests in Natal and Zululand, most Coast Forests occur in small patches on south aspects, in kloofs, and in relatively protected situations. Most of the small patches are predominantly subclimax, but traces of the climax can often be seen.

The Coast Forests comprise:

(i) Coast Lowlands Forest from near sea level to 1,500 ft altitude, the most tropical of the forests in the Tugela Basin (Swamp Forest, see section 5.5).

(ii) Semi-coast Forest, from 1,500 to 3,500 ft altitude. Physiognomically this resembles the Uplands Forests (Chapter 8), but in species composition shows affinities with Coast Lowlands Forest.

(a) COAST LOWLANDS FOREST

In comparison with Semi-coast Forest of the Coast Hinterland Region, Coast Lowlands Forest is shorter, denser and more luxuriant. Although the forest is evergreen, some species are deciduous where they occur in less favourable situations, as, for example, *Ficus spp.* and *Albizia adianthifolia*.

In the Coast Lowlands Region of the Tugela Basin, climax forest has been replaced by sugar cultivation, or by Coast Thorn Scrub and secondary scrub-forest (Photo. 19). Indications of the character of the original forest are thus extremely scanty and the following description must be regarded as incomplete. When the sugar industry was still in its infancy Fourcade (1889) recorded that although Coast Forest was still extensive: 'Nearly the whole of the cultivated land in the Coast districts consists of cleared bush ground . . . Yellow wood (i.e. *Podocarpus spp.*) and wagonwood were formerly cut in many of the coast forests, but there are few good timber trees now left.'

Prior to the advent of the European settler the Coast Lowlands Region was well populated by the Zulus (Chapter 4). Thus, although destruction of the forest has increased during the past hundred years, it probably commenced with the arrival of the Bantu in Natal.

Coast Lowlands Forest is generally from 25 to 50 ft high. Along streambanks and in the deeper kloofs slightly further inland in the Coast Lowlands Region it may be up to 60 ft in height. The community is dense, especially where, as is usually the case, secondary influences are present. Climbers are more numerous

than in forests further inland, but epiphytes are less frequent.

Composition: The following lists of species are incomplete, due to the scanty forest relics in the Tugela Basin area but, nevertheless, are sufficient to characterise the community. Trees of the upper canopy include:

Trichilia emetica	Casearia junodii
Protorhus longifolia	Halleria lucida
Antidesma venosum	Cryptocarya woodii
Bridelia micrantha	C. latifolia
Ficus natalensis	Rapanea melanophloeos
Apodytes dimidiata	Kiggelaria africana
Syzygium cordatum	Ptaeroxylon obliquum
Croton sylvaticus	Scolopia zeyheri
Millettia grandis	Cussonia chartacca
Sideroxylon inerme	C. umbellifera
Chaetacme aristata	Combretum kraussii
Albizia adianthifolia	Vepris undulata
Ekebergia capensis	Nuxia floribunda
Harpephyllum caffrum	Strychnos henningsii
Maytenus peduncularis	S. innocua ssp. gerrardii
Celtis africana	Mimusops obovata
Rhus legatii	Cordia caffra
Ziziphus mucronata	Sapium ellipticum
Bequaertiodendron natalense	

On rocky mesoclines *Commiphora caryaefolia* and *C. harveyi* are prominent, while in the streambank facies the principal trees are *Macaranga capensis* and *Rauvolfia caffra.*

Smaller trees, generally from 10 to 20 ft high, form a denser stratum than in forest further inland. Species include:

Trimeria grandifolia	Deinbollia oblongifolia
Calpurnia subdecandra	Acokanthera oblongifolia
Grumilea capensis	Fagara capensis
Allophylus dregeanus	Diospyros natalensis
A. melanocarpus	D. whyteana
Clausena anisata	Eugenia zeyheri
Rothmannia globosa	Maytenus nemorosus
Gardenia neuberia	Rawsonia lucida
Euclea natalensis	Drypetes arguta
Kraussia floribunda	Rinorea natalensis
Peddiea africana	Eugenia natalitia
Nuxia oppositifolia	

Shrubs and small trees up to 10 ft high include:

Maytenus mossambicensis	Pavetta lanceolata
M. undatus	P. spp.
Cussonia kraussii	Tricalysia capensis
Dovyalis rhamnoides	T. spp.
Canthium ciliatum	Diospyros cordata
Carissa bispinosa	Dracaena hookeriana
Popowia caffra	Uvaria caffra

Phoenix reclinata and *Strelitzia nicolai* occur near streambanks.

Typical field layer species which may be abundant include:

Indigofera micrantha	Asparagus spp.
Cyperus albostriatus	Aneilema dregeanum
Setaria chevalieri	Commelina africana
Thunbergia natalensis	Justicia flava
Dactyloctenium australe	Acanthaceae and many
Digitaria diversinervis	other species
Oplismenus hirtellus	

Amongst the many climbers are:

Dalbergia armata	Uvaria caffra
D. obovata	Cnestis natalensis
Acacia kraussiana	Abrus precatorius
Entada spicata	Acridocarpus natalitius
E. wahlbergii	Embelia ruminata
Asparagus falcatus	Flagellaria guineensis
Smilax kraussiana	Potamophila prehensilis
Rhoicissus capensis	Dioscorea cotinifolia
R. rhomboidea	Diospyros villosa
R. tridentata	D. simii
Secamone alpinii	Cissampelos torulosa
Cissus fragilis	Helinus integrifolius
Cyphostemma spp.	Thunbergia dregeana
Capparis tomentosa	Pupalia atropurpurea
Popowia caffra	Hyalosepalum caffra

Epiphytes are generally not as conspicuous as in the interior forests. Parasites are occasionally found.

The general description and composition of Coast Lowlands Forest given above is similar to those given by Bews (1920), Henkel, Ballenden and Bayer (1936), Bayer (1938) and Acocks (1953). Because of the few forest remnants this description is far from complete, and undoubtedly reflects secondary influences.

(b) SEMI-COAST FOREST

Distribution and general ecology: Semi-coast Forest (see following discussion) is represented by the extensive Nkandla Forest (Photos. 21 and 22), the lowest parts of the Qudeni Forest (Photo. 23), and by a number of impoverished remnants in the remaining areas of the Coast Hinterland Region. Nkandla, occurring towards the upper distributional limits of the association, shows transitional features to Mist Belt Mixed *Podocarpus* Forest, which includes most of Qudeni Forest (Chapter 8).

The Nkandla Forest area under the control of the Department of Forestry is 5,460 acres in extent, the greater part being covered by forest. The forest extends from 2,500 to 4,000 ft on steeply undulating country with a predominantly south aspect, but in which north aspects are also frequent. The mean annual rainfall is between 1,001 mm. and 1,250 mm. (possibly even higher), and is higher in the upper parts than in the lower parts. Much precipitation is in the form of mist. On the steep topography, cold air is able to drain well into the valley at night, only light frosts occurring in the forest area (Chapter 2). On the exposed ridges some of the forest wind effects are apparent, but most of the forest is protected from the hot dry north-west berg winds. Soils are shallow on the ridges and deep

slopes where rock outcrops appear. Fairly deep soils occur at the bottom of some of the minor valleys. Soils are leached types, derived from the Insuzi, Nkandla and Archaean Granite geological formations.

In the Qudeni Forest, the lowest Semi-coast portion is indicated by the presence of species such as *Protorhus longifolia*, *Croton sylvaticus* and *Trichilia emetica*. Occurring mainly along streams, it forms the furthest extension inland of Semi-coast Forest. Here, topography is steep with a predominantly southerly aspect. Climatic features of the lower Qudeni Forest are similar to those indicated for Nkandla Forest, important features being that the mean annual rainfall of the semi-coast parts of the Qudeni Forest is considerably less and temperatures are warmer than in the upper Mist Belt Mixed *Podocarpus* Forest. Snow recorded on the summit of Qudeni does not reach the Semi-coast Forest. In addition, the lowest parts of the Qudeni Forest are less exposed to winds, especially to the cold, southerly winds of winter.

Immature and secondary relics of Semi-coast Forest occur in the remaining areas of the Coast Hinterland Region down to nearly 1,500 ft. All the stands are associated with a rather high, misty rainfall, similar to that of the Nkandla Forest. Coastwards from Nkandla, affinities with Coast Lowlands Forest become increasingly more evident as temperatures become higher, and climatic conditions generally tend towards those in the Coast Lowlands Region.

History of utilization: The Nkandla Forest is one of the traditional forests of the Zulu people and it was frequently used as a refuge during the unsettled Early Bantu period. Lister (1902) reported that: 'The forest has never been worked by sawyers, but it is open to Natives to cut whatever trees they require for their own use. At the time of my visit there was a large hunting party ranging through the forest. Many of the Natives had guns and it appears they are allowed to kill as much game as they please.'

In the present century more control has been exercised over the Nkandla Forest since it has fallen under the jurisdiction of the Department of Forestry, but because of its remoteness and inaccessibility adequate supervision is difficult.

Almost all margins of Semi-coast Forest show evidence of retreat due to veld burning and disturbance, except where protected by major topographic features, such as cliffs. The lower, less protected margins are usually affected, and evidence of former forest extent can often be gauged by the relics along streams (Photos. 24–26).

In both Nkandla and Qudeni Forests are a number of *Themeda triandra* and secondary *Aristida junciformis* Grassland patches, varying in size from about a half, to several acres in extent. These usually occur on hills and ridges, and are evidently burnt fairly regularly. In the Nkandla Forest they are grazed by cattle. Many patches, increasing in extent by retreat of the surrounding forest margins, tend to link up with one another and with the grassland surrounding the forest. Other small patches are not increasing in size, but are nevertheless relatively stable, as there is little evidence of any forest invasion, despite the obvious availability of forest seeds. Fire is almost certainly the main factor limiting the invasion of forest into the grassland. It is apparent here, and throughout the Tugela Basin, apart from the Coast Lowlands Region, that once forest has been replaced by grassland there is a very slow re-establishment of forest, even if only occasional burning takes place. The origin of the grassland patches in the middle of the forests seems to be secondary, due to Bantu living in the forest at one time, while some may also have originated from destruction by people working the forests during the late nineteenth and early twentieth centuries.

Structure and composition: Forest margin and precursor species, occurring in open parts of the Forest, have generally been omitted from the following lists of species (see section 5.5).

The tallest trees in Semi-coast Forest, emergent from the continuous upper canopy, are generally from 50 to 80 ft high. On deep soils and in kloofs they may be over 90 ft high, whereas on rocky ridges, common in the Nkandla Forest, the tallest may only average 40 to 50 ft. The average diameter at breast height is from 15 to 36 ins, but several specimens with diameters between 3 and 6 ft have been found. Frequent to abundant species are:

Olea capensis ssp. macrocarpa	Rapanea melanophloeos
Homalium dentatum	Brachylaena transvaalensis
Combretum kraussii	Nuxia floribunda
Cryptocarya latifolia	Syzygium gerrardii
Kiggelaria africana	Vepris undulata

Occasional to frequent or local species are:

Faurea macnaughtonii	Calodendrum capense
Celtis africana	Ptaeroxylon obliquum
Harpephyllum caffrum	Fagara davyi
Olinia radiata	Ficus natalensis
Podocarpus latifolius	Clerodendrum sp. (?)
	Cussonia chartacea

In addition, there is a number of emergents which it

has not been possible to identify with any certainty. They probably include *Pygeum africanum* and *Ocotea bullata*.

At Nkandla, *Olea capensis* is distributed throughout the forest. *Homalium dentatum* is locally dominant. The low relative abundance of *Podocarpus latifolius* and *Ptaeroxylon obliquum* is probable due to past utilisation.

Along streambanks, dominant emergents are *Ficus capensis* and *Ilex mitis*.

In the continuous upper canopy, broken only by the emergents, additional frequent to abundant trees, from 45 to 60 ft high, are:

Xymalos monospora	Cussonia umbellifera
Protorhus longifolia	Maytenus peduncularis
Croton sylvaticus	Drypetes gerrardii
Linociera peglerae	Nuxia congesta
Trichilia emetica	Cryptocarya woodii
Scolopia zeyheri	Strychnos henningsii
S. mundtii	Halleria lucida

Occasional to frequent or local species include:

Curtisia dentata	Casearia junodii
Ekebergia capensis	Apodytes dimidiata
Rhus legatii	Seemannaralia gerrardii

In the discontinuous subordinate tree layer, from 12 to 40 ft high, the trees are generally less than 12 ins in diameter, usually from 4 to 8 ins in the upper taller trees and less in the lower, small trees. Frequent to abundant trees in the upper, 25 to 40 ft, portion of the subordinate tree stratum, are:

Cassipourea gummiflua	Diospyros whyteana
C. gerrardii	Cassine papillosa
Ochna arborea	Cassinopsis tinifolia
O. natalitia	Drypetes arguta
Eugenia zeyheri	

Less frequent are:

Bequaertiodendron natalense	Bersama tysoniana
Mimusops obovata	Garcinia gerrardii

In the lower, 12 to 25 ft, portion of the subordinate tree stratum, composed of small, slender trees, the principal species are:

Rinorea natalensis	Rawsonia lucida
Peddiea africana	Duvernoia adhatodioides
Trimeria grandifolia	Clausena anisata
Grumilea capensis	Allophylus dregeanus
Rothmannia globosa	Solanum mauritianum
Oxyanthus gerrardii	Calpurnia subdecandra
Gardenia neuberia	

Rinorea natalensis is the dominant small tree. *Duvernoia adhatodioides* and *Solanum mauritianum* are dominant where the upper canopy is reduced or broken.

Shrubs, from 3 to 10 ft high, form a discontinuous stratum and include:

Cassinopsis ilicifolia	Justicia campylostemon
Carissa bispinosa	Indigofera natalensis
Pavetta natalensis	Cnestis natalensis
P. tristis	Desmodium repandum
Dovyalis rhamnoides	Micrococca capensis
D. lucida	Excoecaria simii
Tricalysia capensis	Mackaya bella
Canthium ciliatum	Piper capense (moist areas)

Herbaceous field layer species up to 4 ft high, include:

Oplismenus hirtellus	Plectranthus tomentosa
Cyperus zuluensis	P. fruticosus
Streptocarpus spp.	P. laxiflorus
Impatiens duthieae	P. dolichopodus
Hypoestes verticillaris	P. ciliatus
H. triflora (moist areas)	P. ecklonii
H. aristata	P. natalensis
Dicliptera heterostegia	ferns and many others

In the Nkandla Forest the field layer is poorly developed, a feature due, at least in part, to the presence of cattle. In other forests, such as at Kranskop and Qudeni, the field layer is eonsiderably richer, possibly because of higher soil moisture than is found in mueh of Nkandla.

Ground layer plants found in the forest include mosses, liverworts, lichens, *Selaginella kraussiana*, *Streptocarpus spp.* and various other small plants, all mainly in the moister parts. Many of the species may also be epiphytic.

Climbers include:

Cnestis natalensis	Rhoicissus rhomboidea
Bachmannia woodii	R. capensis
Diospyros simii	Senecio tamoides
Cassine tetragona	S. macroglossa
Popowia caffra	Canthium gueinzii
Dalbergia armata	Cissampelos torulosa
D. obovata	Helinus integrifolius
Secamone alpinii	Smilax kraussiana
S. gerrardii	Behnia reticulata
Strophanthus speciosus	Potamophila prehensilis
Scutia myrtina	Dioscorea cotinifolia
Uvaria caffra	D. dregeana
Acridocarpus natalitius	Clematis brachiata
Entada spicata	Riocreuxia torulosa
Coccinia palmata	Ceratiosicyos laevis

The first fifteen species may develop thick, woody stems and reaeh the upper canopy. The remaining species are predominantly semi-woody or herbaceous, occurring mainly under the greater light intensity of a broken canopy or on the forest margins. The majority of these species, it will be noted, have been listed as forest precursors (section 5.5).

Epiphytes are less frequent in Semi-coast Forest than in the Mist Belt Mixed *Podocarpus* Forest, whieh has a higher rainfall and more misty climate. Apart from abundant lichens and mosses, the principal species in Semi-coast Forest include *Dermatobotrys saundersii*, *Peperomia reflexa*, *P. retusa*, *Polypodium* [illegible], *P. lineare*, *Asplenium spp.* and, near the [illegible], *Rhipsalis baccifera*. The strangler fig, *Ficus* [illegible], is epiphytie in the early stages of its growth.

Parasites are represented occasionally by *Loranthus subcylindricus* and other species of the genus.

Occasional wind-throws, especially on the shallower soils, and lightning blasted trees, cause a break in the upper forest canopy, resulting in a prolific growth of climbers, herbaceous undergrowth, forest margin and precursor species.

Special physiognomic and structural features: The majority of the trees in Semi-coast Forest is evergreen. A number of species, however, is irregularly deciduous. Irregularly deciduous and deciduous species are: *Homalium dentatum*, *Combretum kraussii*, *Croton sylvaticus*, *Celtis africana*, *Calodendrum capense*, *Kiggelaria africana*, *Ficus capensis*, *Rhus legatii*, *Seemannaralia gerrardii*, *Trimeria grandifolia*, *Calpurnia subdecandra* and *Clausena anisata*.

Plank buttresses occur in *Syzygium gerrardii* and spur buttresses in a number of trees, especially on sloping ground, for example, *Celtis africana*, *Vepris undulata*, *Calodendrum capense* and *Drypetes gerrardii*.

Cauliflorous species are *Rapanea melanophloeos*, *Halleria lucida* and *Ficus capensis*.

Spinosity is evident mainly in the lower strata. Species include the canopy tree, *Scolopia zeyheri*, and the smaller *Gardenia neuberia*, *Carissa bispinosa*, *Canthium ciliatum*, *Maytenus mossambicensis*, *Dovyalis rhamnoides*, *Cassinopsis ilicifolia*, *Dalbergia armata* and *Scutia myrtina*. The trunk of the canopy tree, *Fagara davyi* (knobwood) is generally covered with rather sharp-pointed, cone-shaped protuberances or "knobs".

Discussion: In the absence of fire and disturbance, successional trends show that Semi-coast Forest is the climatic climax of the Coast Hinterland Region. The presence of a more or less continuous series of fast disappearing relics, together with the successional evidence, suggests that the existing forests were once far more extensive and may be remnants of a once great forest extending inland from the Coast Lowlands Region. Forest has persisted longer on the cooler, moister south-facing slopes than on the warmer, drier north-facing slopes, where it is more susceptible to adverse fire and secondary factors.

Semi-coast Forest, from approximately 1,500 to 3,500 ft altitude, represents one of three montane types of forest occurring inland of the Coast Lowlands Region. At higher altitudes are Mist Belt Mixed *Podocarpus* Forest, from 3,500 to 4,500 ft altitude, and Mountain *Podocarpus* Forest, from 4,500 to 6,500 ft. Bews (1912–1930) and Bayer (1938) grouped Semi-coast Forest and Mist Belt Mixed *Podocarpus* Forest into a broader Midland Forest, but Acocks (1953) classified the forest as in the present account.

Because of the number of species common to Coast Lowlands Forest and Semi-coast Forest, these forests have been grouped together as Coast Forests. In a similar manner, Mist Belt Mixed *Podocarpus* Forest and Mountain *Podocarpus* Forest may be grouped together as Uplands *Podocarpus* Forest (see Chapter 8).

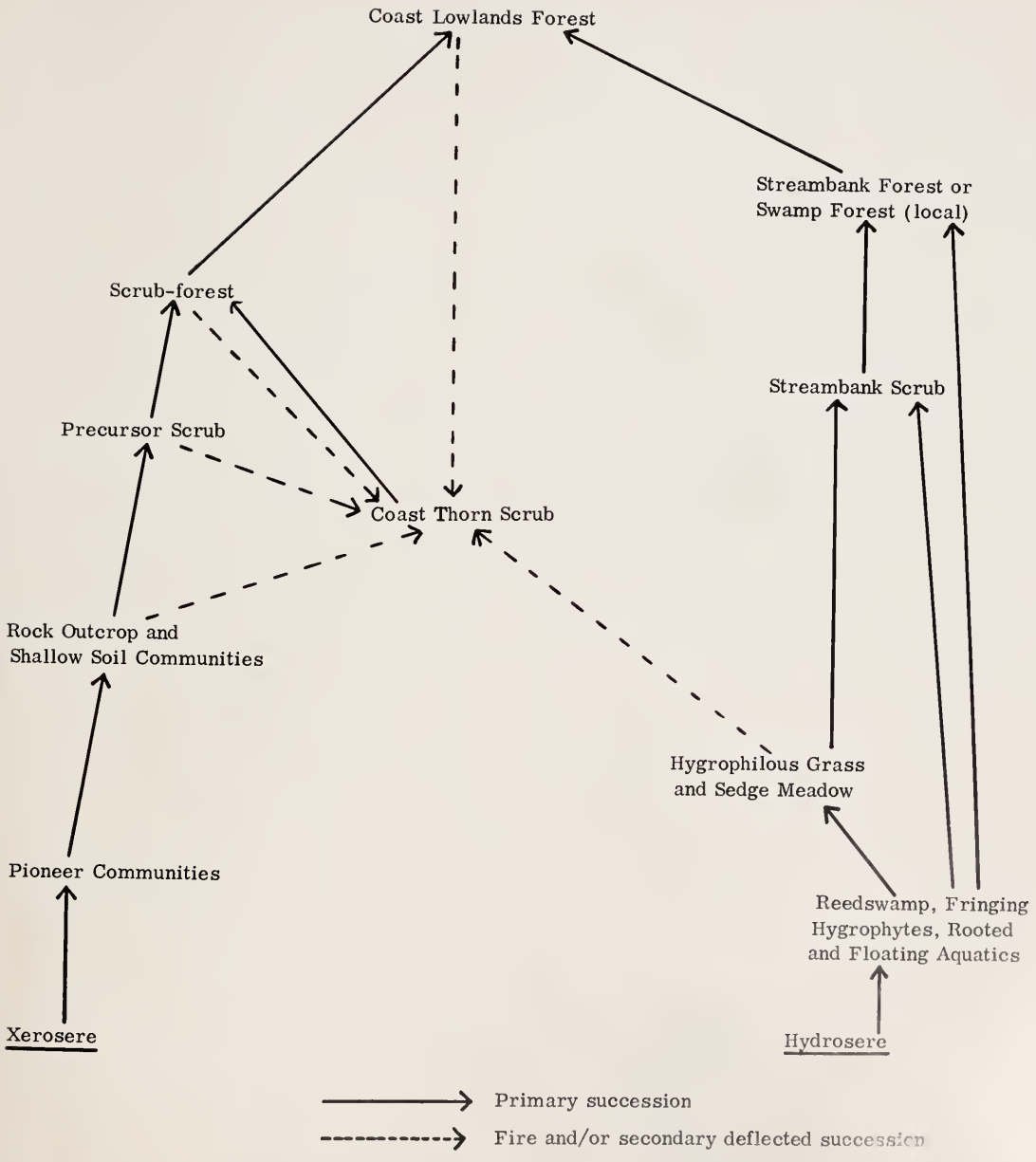


Fig. 15 Generalised community interrelations in the Coast Lowlands (tentative)

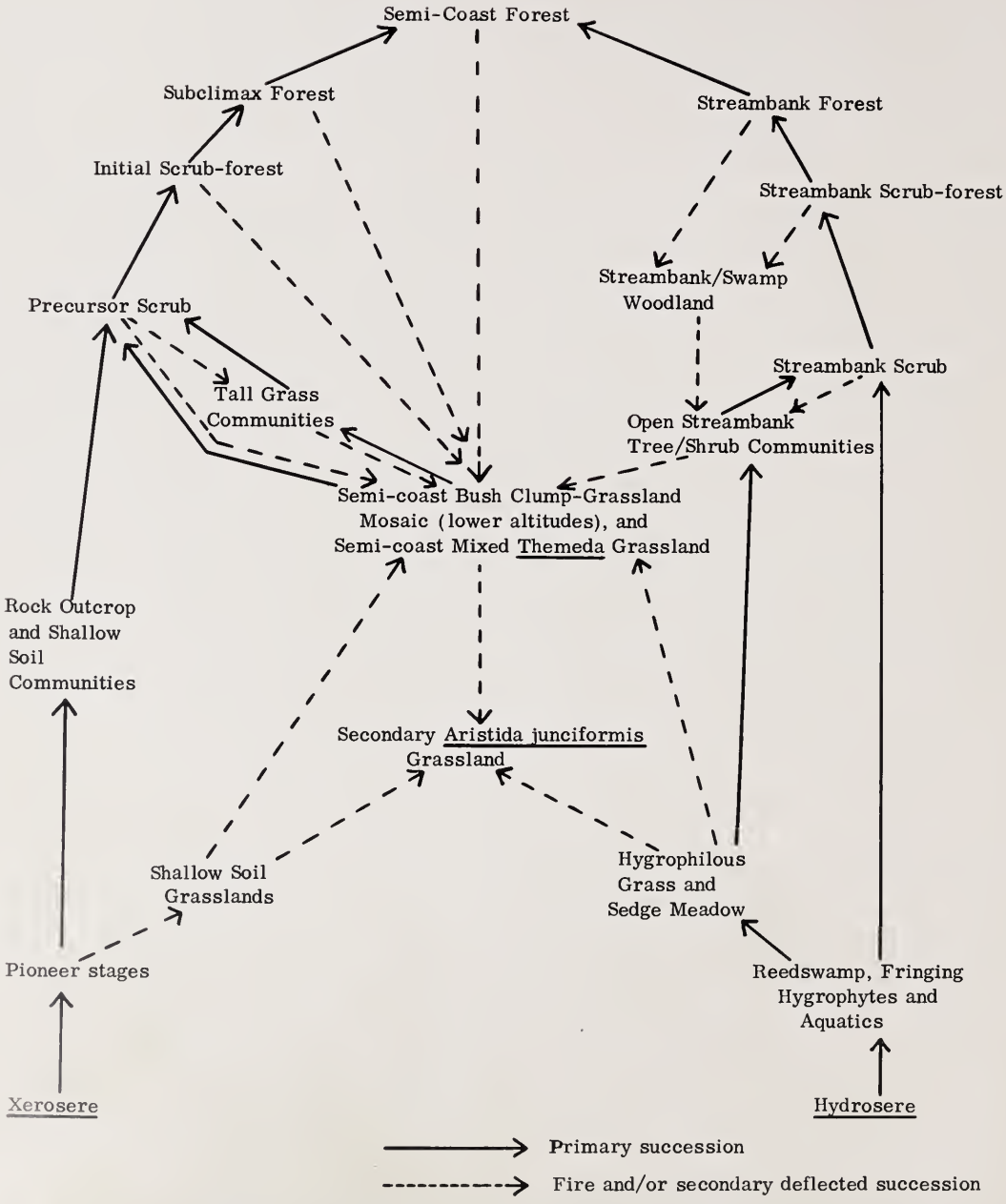


Fig. 16. Generalised community interrelations in the Coast Hinterland

CHAPTER 6

VALLEY VEGETATION

The vegetation of the Valley Region extends from 8 to over 100 miles inland from the sea with outlying patches to 150 miles inland in the western Interior Basins Region. Most of this lies between 3,000 and 3,500 ft altitude but the outliers may be at 5,000 ft.

Valley vegetation types cover approximately 2,920 square miles, or 26% of the area of the Tugela Basin. Of this, nearly 2,000 square miles is covered by *Acacia karroo-A. nilotica* Thorn Veld types which represent a marginal vegetation to the Dry Valley Scrub and Savanna in the drier parts of the Valley Region (Map 1).

Through most of the area covered by dry Valley vegetation much secondary disturbance of the vegetation is evident. In many instances the deterioration of vegetation and soils represents nearly the maximum possible: almost completely bare rock has been exposed.

6.1 Aquatic and Hygrophilous Vegetation

Hygrophilous vegetation in the Valley Region is mainly riverine, vleis being rarely found.

The climax, woody hygrophilous communities are broadly correlated with the climatic gradients from the Lower Valley Sub-region to the Interior Valley Sub-region, and from the driest parts of the Valley Region to the moister marginal areas (see Chapter 2). These climax communities are more mesophytic than, and bear a post-climax relationship to, the surrounding drier communities.

Because of current overgrazing, fire is not a deflecting factor in the hydrosere of the Valley Region. This is one of the principal differences in hydrosere development between this and other ecological regions of the Tugela Basin. Heavy disturbance by man and animals of vegetation is found along the main rivers.

(a) THE RIVERINE HABITAT

Important factors affecting the hygrophilous vegetation of the Tugela River and its tributaries are the swift currents and the considerable fluctuations in level of the rivers and streams between winter and summer and in floods. One result is a paucity of floating aquatic plants. Depending on the rise and fall of the rivers and on soil moisture conditions, three main zones of river and streambank vegetation can generally be distinguished:

(i) A lower fringing zone, submerged during high flow periods;

(ii) A middle zone, fringing during high flows and submerged during floods; and

(iii) An upper zone, fringing only during floods.

As a result of frequent removal by floods of the lower zone, and also because of the slumping of the river banks, the middle and upper zones may occupy a fringing position. Because of increased soil moisture, there is then developed a mixture of more hygrophilous earlier seral species together with persistent, less hygrophilous, later seral species.

In addition to zoning due to moisture, substrata also exert an influence upon the type of community found. Two principal substrate habitats are found.

(i) Gravelly, stony, rocky, boulder beds and banks. In the lower fringing zone, plants exposed to considerable current forces are strongly rooted species wedged into cracks and crevices between stones and boulders. On rocky riverbanks above the normal high flow or middle zone, the vegetation is a curious mixture of hygrophilous and xerophytic species.

(ii) Sand, mud, and alluvial riverbanks. These are often unstable and may be carried away by floods. Large quantities of silt are carried by the rivers during floods—as much as 3% by weight has been recorded*—this being deposited when the velocity of the flood decreases. Thus islands of silt often build up around rock obstructions

* Kindly analysed by Mr. W. D. Ohlf from a sample obtained from the Insuzi River in flood

where plant growth is sufficient to reduce the velocity of the current. These deposits are later readily colonised by plants.

(B) AQUATIC COMMUNITIES

Submerged aquatic communities reach their maximum development during low flows in late summer, autumn and winter. They consist principally of species of various algae: *Spirogyra*, *Cladophora*, *Nitella* and Cyanophyceae.

The branching, thallus-like plants of the highly specialised angiosperm, *Tristicha trifaria*, occur very locally on rocks in rapids.

Floating aquatics are seldom found, but the introduced, potential weed, *Eichornia crassipes*, has been observed in small quantities below Colenso.

(C) REEDSWAMP AND FRINGING HYGROPHILOUS COMMUNITIES

The strongly rooted plants, *Pennisetum natalense*, *Cyperus marginatus*, *Anoiganthus breviflorus* and *Ornithogalum zeyheri* are typical pioneers in crevices amongst boulders and rocks in the lower fringing zone. These communities, from 8 ins to 3 ft high, may ultimately impede the stream flow sufficiently to become covered over with silt, which may be invaded by fringing plants typical of this substratum type. Such fringing hygrophytes, occasionally forming communities in the uninterrupted hydrosere on silt substrata, include herbs such as *Polygonum spp.*; sedges such as *Cyperus spp.*, *Pycreus spp.*, *Kyllinga spp.* and *Mariscus spp.*; rushes such as *Juncus spp.* and *Eleocharis spp.*; the hygrophilous grasses, *Leersia hexandra*, *Arundinella nepalense*, *Echinochloa crus-pavonis* and *Dichanthium aristatum*; and the shrubs *Ficus capraefolia* and *Salix woodii* (see Chapter 7).

The most important fringing community on sand, mud and alluvial banks of the larger rivers, is the *Phragmites communis* Reedswamp. These communities, up to 8 ft in height, are often destroyed by floods, especially where they have been able to build up over a period of years and have extended into the main stream. The removal of such *Phragmites* dominated banks leaves later successional stages, particularly *Cynodon dactylon* Grassland (see (D)), as 'fringes' to the river.

Phragmites is used by the Bantu for thatching and other domestic purposes, while cattle also damage the Reedswamp (Photo. 30). Development of Reedswamp is thus deflected to a secondary community, particularly to that dominated by *Cynodon dactylon*.

Other Reedswamp communities are infrequent. They include *Typha capensis* Reedswamp, found occasionally in cut-off meanders, and *Miscanthidium junceum* Reedswamp, which occurs chiefly in the Interior Basins Region, but extends into the Valley Region (see Chapter 7).

(D) RUDERAL AND HYGROPHILOUS GRASS COMMUNITIES

These communities occur mainly in the middle and upper zones on alluvial river banks. Sedge Meadow, which usually appears together with Hygrophilous Grass Meadow in the Interior Basins Region, is poorly represented in the Valley Region. Apart from the widespread *Cynodon dactylon* Grassland, Hygrophilous Grass Meadow is also limited in extent compared with its development in the Interior Basins and Uplands Regions.

Numerous ruderal communities, appearing on newly deposited silt, are composed of annual weeds such as *Xanthium pungens*, *Zinnia multiflora* and *Tagetes minuta* (Photo. 31).

Small communities of the hygrophilous grasses, *Arundinella nepalense*, *Hemarthria altissima*, *Beckeropsis uniseta*, *Imperata cylindrica* and *Paspalum distichum* and the exotics, *P. dilatatum* and *P. urvillei*, occur in the middle and upper zones along rivers and streams. The relative sparseness of these communities in the Valley Region is due to heavy disturbances (see Chapter 7).

Occurring extensively along sandy banks and islands of the Tugela is a grassland dominated by *Cynodon dactylon*. It consists of a pure, short, dense cover of the stoloniferous and rhizomatous dominant species. Under the prevailing heavy grazing, the community is relatively stable and forms the culmination of the hydrosere; but in the absence of grazing, development would be towards Hygrophilous Woodland (see (F)). *C. dactylon* is of considerable importance in stabilising and protecting heavily grazed river banks, as well as providing fodder for stock in the surrounding overgrazed Bantu areas.

(E) OPEN HYGROPHILOUS TREE AND SHRUB COMMUNITIES

Open tree and shrub communities, varying from isolated individuals to small groups of trees and shrubs, from 5 to over 25 ft high, occur commonly along rivers and streams where disturbance is intense. The communities are analagous to those of the Coast Vegetation described in Chapter 5.

DCA
DCA
Et
2y
2y
2y
2y
2y
2y
2y
2y
2y
Sp
Sp
Sp
Sp
Et
P
Rt
Ca
Et

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Photo. 28. General view showing Valley Vegetation in Middledrift area of Tugela Valley. View east from Imbolonga (Zizi) Hill, Trigonometrical survey beacon 80.

Ca = *Combretum apiculatum* Tree Veld on shallow, stony soils.

DCA = Dry Coast *Acacia karroo-A.nilotica* Thorn Veld of Marginal and Transitional Valley Vegetation.

Et = *Euphorbia tirucalli* Succulent Scrub. Note density and almost complete confinement to south side of Tugela River. Locally in foreground, and in centre distance where Tugela River swings south, *E.tirucalli* extends on to north side of Tugela River.

P = *Phragmites communis* islands and Hygrophilous Vegetation.

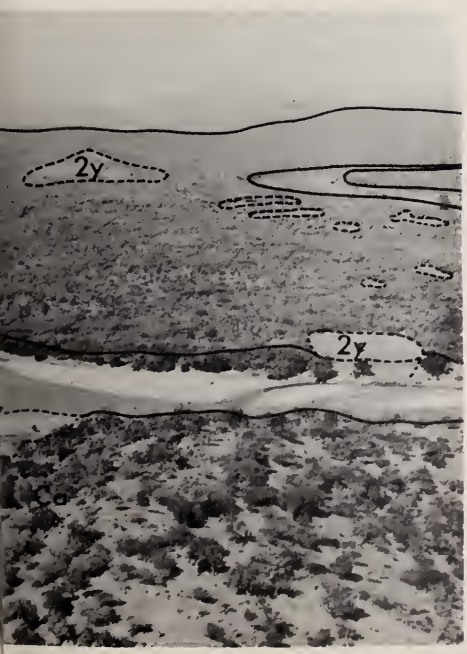
Ri = Riverine Woodland of *Trichilia emetica, Ficus sycamorus,* etc.

Sp = *Spirostachys africana* Valley Woodland. Largely decimated and composed of relics only.

2y = Secondary vegetation, cultivated fields, and secondary *Acacia tortilis.*

—— = Primary vegetation boundaries.

..... = Vegetation boundaries obscured by disturbance, cultivation, etc.



Frequent to abundant species are (LTV = Lower Valley Sub-region):

- Salix woodii
- Ficus capracfolia (LTV)
- F. sycamorus (LTV)
- Trichilia emetica (LTV)
- Combretum erythrophyllum
- Acacia karroo
- A. robusta
- Spirostachys africana
- Austromimusops dispar
- Mimusops obovata (forma)
- Syzygium guineense (LTV)
- Ficus capensis
- Melia azedarach (introduced)
- Ricinus communis
- Maytenus cymosus (forma DE 958)
- Acalypha glabrata
- Pavetta lanceolata (LTV)

Occasional species include:

- Rauvolfia caffra (LTV)
- Vitex harveyana (LTV)
- Phoenix reclinata (LTV)
- Salix babylonica (introduced)
- Syzygium cordatum (LTV)

In addition to the hygrophilous species listed, there are numerous other species, especially on rocky streambanks where an hygrophilous vegetation is not clearly defined. These include plants listed for the various non-hygrophilous Valley communities described later in this Chapter. *Acacia karroo*, *A. robusta* and *Spirostachys africana*, in the lists above, are such species which are particularly common on streambanks, in addition to their prevalence elsewhere.

Salix woodii Scrub, up to 15 ft high, occurs locally in the Valley and Interior Basins Regions as a fringing community. Shorter open communities of 6 ft in height are, however, more common in these regions, as well as in the Uplands.

Open Hygrophilous Tree and Shrub Communities represent either initial stages of woody plant invasion in the hydrosere or are secondary relics of Riverine and Streambank Woodland. Under present conditions in the Valley Region, the open community form is maintained by disturbance other than fire.

(f) RIVERINE AND STREAMBANK WOODLAND

Riverine and Streambank Woodland occurs on islands in the Tugela that are protected from disturbance for the greater part of the year, and also along steep tributary streams that have low population densities in their vicinity because of a paucity of cultivable alluvium.

In the zone of high soil moisture found for some 20 to 50 yards on either side of rivers and streams, Riverine and Streambank Woodland represents a postclimax to the surrounding drier Valley vegetation.

The principal Riverine and Streambank Woodland communities found are: *Ficus sycamorus* Woodland, *Combretum erythrophyllum* Woodland, *Acacia karroo* Riverine and Streambank Woodland.

Ficus sycamorus Woodland. Along the Tugela in the Lower Valley Sub-region, *F. sycamorus* is the dominant species and occurs together with *Trichilia emetica*, *Syzygium guineense*, *Acacia robusta* and *Spirostachys africana*. The dominant, *F. sycamorus*, may attain a height of over 70 ft and a large canopy cover (Photo. 32).

Combretum erythrophyllum Woodland. These deciduous communities are frequently in the form of a tall scrub, up to 15 ft high, but where they reach their maximum development they form a woodland, from 20 to 30 ft in height. They are important in the Interior Valley Sub-region.

Acacia karroo Riverine and Streambank Woodland. A. karroo, a widespread dominant in the marginal Valley Region *A. karroo-A. nilotica* Thorn Veld, also forms a tall woodland, from 20 ft to 35 ft high, along rivers and streams, especially on heavy, dark clay soils. It is abundant along smaller seasonal streams, and sometimes occurs in a drier zone adjacent to *Combretum erythrophyllum* Woodland.

The various species found in *Ficus sycamorus* Woodland, *Combretum erythrophyllum* Woodland and *Acacia karroo* Riverine and Streambank Woodland are given in the following composite lists. Species which occur as forest initials and forest precursors in moist regions increase in importance towards the margins of the Valley Region.

Abbreviations used in the following lists are:

- LTV = Lower Valley Sub-region
- ELTV = Eastern part of Lower Valley Sub-region
- ITV = Interior Valley Sub-region
- MVS = Marginal Valley Region
- FP = Forest precursors in moist regions
- FI = Forest initials in moist regions

Frequent to abundant species, including the dominants, in the upper tree layer over 25 ft high are:

- Ficus sycamorus (LTV)
- Trichilia emetica (LTV) (FI)
- Combretum erythrophyllum
- Acacia karroo
- A. robusta
- Spirostachys africana
- Syzygium guineense (LTV)
- Ficus capensis (FI)
- Ziziphus mucronata
- Schotia brachypetala
- Celtis africana (FI)
- Rhus legatii (FI)
- Melia azedarach (introduced)
- Sideroxylon inerme
- Acacia sieberiana (MVS)
- Dais cotinifolia (FP)

Occasional species of the upper layer include:

- Syzygium cordatum (LTV)
- Trema orientalis (LTV) (FP)
- Phyllogeiton zeyheri
- Chaetacme aristata (LTV) (FI)
- Ekebergia capensis (FI)
- Turraea floribunda (LTV) (FI)
- Nuxia congesta (LTV) (FI)
- Halleria lucida (MVS)
- Kiggelaria africana (MVS) (FI)
- Rapanea melanophloeos (MVS)
- Bridelia micrantha (FI)
- Croton sylvaticus (FI)
- Apodytes dimidiata (FI)

Euclea natalensis (LTV) (FP)
Ficus natalensis (LTV) (FI)
Harpephyllum caffrum (FI)
Cryptocarya woodii (FI)
Drypetes arguta (ELTV) (FI)
Commiphora caryaefolia (FP)
C. harveyi

In the lower tree layer, from 15 to 25 ft high, are:

Austromimusops dispar
Mimusops obovata (forma)
Rhus rehmanniana
Hippobromus pauciflorus (FP)
Clausena anisata (FP)
Fagara capensis (FP)
Erythrina lysistemon (FP)
Allophylus melanocarpus (FP)
Pachystigma macrocalyx (FP)
Rauvolfia caffra (LTV) (FP)
Clerodendrum glabrum (FP)
Heteropyxis natalensis (LTV)
Heteromorpha trifoliata (FP)
Trimeria grandifolia (FI)
Vitex harveyana
Deinbollia oblongifolia (LTV) (FI)

Shrubs from 6 to 15 ft high include:

Acalypha glabrata
Maytenus cymosus (forma DE958)
Putterlickia verrucosa
Dombeya cymosa
Ehretia rigida
Pavetta lanceolata (LTV) (FP)
Diospyros lycioides
Grewia occidentalis (FP)
Calpurnia subdecandra (FP)
Canthium inerme (FP)
Ochna natalitia (FP)
Tecomaria capensis
Vangueria infausta
Phoenix reclinata (LTV) (FP)
Erythrococca natalensis (LTV)
Rhamnus prinoides (LTV) (FP)
Cassinopsis ilicifolia (FP)
Maesa lanceolata (MVS) (FP)

The field layer is generally sparse and composed of shade tolerant grasses and herbaceous plants. Species found include:

Commelina africana
Panicum maximum
Setaria chevalieri
Teucrium riparium
Pellaea viridis
Peristrophe natalensis

Climbers are not abundant except towards the margins of the Valley areas. Species include:

Dalbergia obovata (FP)
Acacia schweinfurthii
A. ataxacantha (MVS) (FP)
Rhoicissus tridentata
Dalbergia armata (LTV) (FP)
Capparis transvaalensis

In addition to the species listed above, there are species from the surrounding dry plant communities (sections 6.3, 6.4.).

6.2 Succulent Vegetation

Communities dominated by plants with succulent stems or leaves are composed principally of species of *Euphorbia* and *Aloe*. Communities of *Euphorbia spp.* are extensively developed in the hottest and driest parts of the Valley Region. Several species of *Aloe* also occur commonly in the Interior Basins Region, and occasionally in the Coast Hinterland and Uplands Regions.

The majority of the succulents are pioneers of the plant succession on rock outcrops and very shallow soils, but many succulent communities are also secondary. Secondary development has occurred on severely eroded soils, destruction of the soil favouring pioneers over other normally later seral species. Establishment and maintenance of secondary succulent communities is, at present, largely because of the selective destruction of vegetation, the absence of competition favouring the growth and spread of useless, unpalatable succulent species.

(a) CRASSULA-PORTULACARIA ROCK OUTCROP COMMUNITIES

Small communities dominated by *C. arborescens* and *P. afra* occur on rock outcrops and cliffs in the drier parts of the Valley Region. The communities are an open scrub, from 6 to 15 ft high, with the dominant plants growing in the rock crevices. *Nautochilus labiatus* is a frequent aromatic shrub, up to 4 ft high.

(b) ALOE COMMUNITIES

Communities dominated by *Aloe spp.* range from those composed of small shrubs, less than 3 ft high, to communities of succulent leaved trees over 25 ft in height. The chief species in order of importance are:

Aloe marlothii
A. spectabilis
A. rupestris
A. mudenensis
A. arborescens
A. bainesii

The two closely related species, *A. marlothii* and *A. spectabilis*, which are not readily distinguishable in the vegetative state and may also hybridise (Reynolds, 1950), form the most characteristic and widespread *Aloe* community in the Tugela Basin. The species occur together in the lower Mooi River valley. Communities of the more widely distributed *A. marlothii* occur up to 5,000 ft altitude in the Utrecht area, whereas *A. spectabilis* is limited chiefly to the Valley Region.

A. marlothii and *A. spectabilis* are characteristic of rock outcrops and very shallow, stony soils, overlying hard sheets of dolerite in the Interior Valley Sub-region and Interior Basins Region, communities being less well developed upon pre-Karroo geological formations of the Lower Valley Sub-region. The communities are open and composed of succulent leaved, single stemmed, unbranched trees from 5 to 15 ft in height (Photo. 33). They occur in pure stands on impervious dolerite koppies of the Interior Basins Region. Where, however, the underlying rock is broken and roots can penetrate into the cracks, various species found in the surrounding communities, especially of *Acacia karroo-A. nilotica*

Thorn Veld, occur as associates. The field layer is sparse and composed of the more xerophytic grasses of shallow soils (Chapter 7). Because of the sparse grass cover and rocks, the *Aloe* communities enjoy considerable protection against fire.

Chiefly in the lower Mooi River valley, *A. marlothii* and *A. spectabilis* have extended greatly upon severely eroded soils to form secondary communities, having developed upon secondary habitats which closely resemble the primary *Aloe* habitats.

Communities of *A. rupestris* occur locally in the Valley Region. The species commonly forms an association with *Euphorbia triangularis* in the lower Mooi River valley, and occurs under similar, relatively mesic habitat conditions (see (D)). *A. rupestris* is a species of high sociability rarely occurring outside a dense scrub. The tall, slender, shallow rooted stems, up to 15 ft high, obtain considerable support from the surrounding scrub. The species is more shade tolerant than other *Aloe* species, permitting its growth in dense scrub.

Small communities of the endemic, *A. mudenensis*, up to 3 ft high, occur frequently on eroded soils in the Interior Valley Sub-region, where they are associated with *Euphorbia triangularis-Aloe rupestris* Scrub and Semi-deciduous Bush. *A. mudenensis* communities closely resemble those of *A. saponaria* found commonly in other parts of the Tugela Basin. *Euphorbia rhombifolia*, a low-growing shrub with small, switch-like succulent stems, occurs commonly with *A. mudenensis*.

A tall, more mesophytic scrub or woodland of *A. bainesii*, up to 25 ft high, occurs on mesoclines and in protected, rocky kloofs of the Valley Region, associated with plants of Mesophytic Kloof and Rocky Hillside Scrub (Section 6.4).

(C) EUPHORBIA PSEUDOCACTUS AND E. GRANDICORNIS SUCCULENT SCRUB

Secondary, succulent shrub consocies of *E. pseudocactus* and *E. grandicornis* are found abundantly in the severely eroded, hot, dry areas of the Valley Region.

E. pseudocactus communities of the Interior Valley Sub-region consist of an open, short scrub, 3 to 4 ft high, with spinescent *E. pseudocactus* in clumps, 3 to 12 ft or more, in diameter (Photos. 35, 47). The ground between clumps is bare, or has a sparse, short field layer of the secondary, low semi-shrub, *Blepharis natalensis*. A heavily grazed, short grass cover of *Urochloa mosambicensis* is also to be found between the *Euphorbia* clumps. Heavily browsed shrubs and trees of *Acacia tortilis* are frequent to abundant.

Secondary consocies of *E. grandicornis*, between Jameson's Drift and Oqaqeni in the Lower Valley Sub-region, closely resemble *E. pseudocactus* Scrub, except that the shrubs are taller, from 5 to 10 ft high, in larger clumps, up to 30 ft or more in diameter, and even more spinescent. In the Middledrift area below Kranskop, associes of *E. grandicornis* with *Croton menyhartii* are common (Photo. 34).

Development and stability of *E. pseudocactus* and *E. grandicornis* communities is due to continuous, heavy, selective utilisation, browsing and grazing of taller, competitive, non-succulent plants, such as *Acacia spp.* and grasses. Even under heavy disturbance, however, the consocies are invaded by taller *Euphorbia spp.*, such as *E. tirucalli* and *E. triangularis*.

An important feature, successionally and from the viewpoints of veld management and the reclamation of *E. pseudocactus* and *E. grandicornis* Scrub to a grassland or savanna, is the protection afforded by the spineseent *Euphorbia* clumps to field layer climax grasses, such as *Themeda triandra*. Any growth of the few grasses in the clumps is grazed within reach of animals, but is protected from close grazing by the thorny *Euphorbias*. If the community, as a whole, is protected from grazing, the grasses grow rapidly and suppress the surrounding clump. Fire in the developing grass field layer hastens the death of the *Euphorbia*. In the reclamation of veld, any attempt at increasing the grass cover by mechanical removal of the *Euphorbia* clumps is thus not only unnecessary, but also certain to eliminate the few remaining grasses.

(D) EUPHORBIA INGENS AND E. TRIANGULARIS COMMUNITIES

E. ingens communities of candelabra-like, succulent trees, up to 20 ft high, occur frequently in the drier areas of the Valley Region. In the Interior Valley Sub-region, they occur on steep hillsides where severe or moderately severe frosts are absent. In the Lower Valley Sub-region, where heavy frosts do not occur, *E. ingens* is also found commonly on the valley floor. *E. ingens* is often prominent in Relic Tree-Secondary species communities (section 6.3 (G)).

E. triangularis Succulent Scrub occurs frequently in the Valley Region and occasionally in the Coastal Lowlands Region (see Chapter 5). The communities are typical of steep, rocky mesoclines, but they occur extensively on north-facing slopes in the Mooi River valley where they occupy a climatic zone between marginal *Acacia karroo-A. nilotica* Thorn Veld and

more xerophytic Semi-deciduous Bush, *Combretum apiculatum-Acacia* Tree Veld and *Euphorbia tirucalli* Succulent Scrub (see Map 1).

The *E. triangularis* community is a rather dense scrub, up to 35 ft high, dominated by succulent, leafless trees. In the lower Mooi River valley, *Aloe rupestris* may be co-dominant (see (B)). Subordinate species are usually the more mesophytic elements of the surrounding associations. *Calpurnia subdecandra* is often dominant in a lower, 5 to 10 ft, shrub layer and *Panicum deustum*, *P. maximum* and various Acanthaceae, in a sparse shade-tolerant field layer. Climbers, such as *Capparis citrifolia*, *Acacia schweinfurthii*, *Clematis brachiata* and *Sarcostemma viminale*, are occasional.

Although the primary *E. triangularis* Succulent Scrub on steep, rocky mesoclines is relatively stable, secondary unstable communities may also be found (Photo. 36). These secondary communities, prevalent in the lower Mooi River valley, have spread from local primary communities following upon severe soil erosion and destruction of the surrounding vegetation. Continuous selective utilisation and destruction of competitive non-succulent vegetation by the Bantu and their stock favours the expansion and development of *E. triangularis*, which is not utilized. *E. triangularis* Scrub shows little or no tendency to expansion except under heavy disturbance.

In the lower Mooi River valley, *E. evansii*, a small tree up to 10 ft high, occurs commonly in secondary consocies of *E. triangularis*, displaying a similar tendency to expansion in the presence of selective utilisation and destruction of competitive species.

(E) EUPHORBIA TIRUCALLI SUCCULENT SCRUB

Distribution and general ecology: Succulent scrub dominated by *E. tirucalli* occurs almost entirely on the south side of the Tugela from Weenen to Maqumbi. A few small outliers are found in the eastern Tugela Valley near Essiena. The western distributional limit of the community coincides with the occurrence of moderately severe or severe frosts around Weenen and in parts of the lower Mooi River valley, *E. tirucalli* being limited to hillsides above the frost hollows. Mean annual rainfall is between 600 mm. and 800 mm. and, locally, up to 900 mm. Soils are alkaline, arid types. The Scrub covers some 120 square miles of the Tugela Basin (see Map 1, Photos. 2, 28, 37–39, 53).

Physiognomy and structure: The community varies from an open, rather short scrub, 10 to 15 ft high, with numerous other tree and shrub species also present, to a dense, tall, closed scrub, 15 to 30 ft or more in height, with fewer associated trees and shrubs. Pure, dense, secondary thickets of *E. tirucalli* are abundant on old lands and on old kraal sites (Photo. 37). The tall, closed scrub forms predominate in the Lower Valley Sub-region, reaching their maximum development in the warm, relatively frost-free and moister climate east of the Mpisi River (see Chapter 2). In the Interior Valley Sub-region, short scrub forms predominate. Although the distribution of this short scrub is broadly correlated with lower minimum temperatures, it is also apparent that, in much of this scrub, *E. tirucalli* has not yet reached maturity and become dominant. Considerable variations in height are found, the scrub being tall on deep soils and on old cultivation.

In dense secondary thickets of *E. tirucalli* there is no shade tolerant field layer, the ground being covered with a characteristic, twiggy litter. In the less dense and common scrub forms of *E. tirucalli* there is, in the absence of stock, a sparse, shade-tolerant field layer. Soil erosion is common as a result of the poor ground cover.

Secondary character: Apart from heavily populated parts in the vicinity of Tugela Ferry, Ngobevu and Middledrift, where Bantu have cleared large areas of *E. tirucalli*, there is considerable evidence that the plant is spreading.

The principal associations which have been invaded by *E. tirucalli* over large areas are *Combretum apiculatum* Tree Veld, Semi-deciduous Bush and *Spirostachys* Valley Woodland. Spread has also taken place into small sections of Dry Coast *Acacia karroo-A. nilotica* Thorn Veld and *Spirostachys-Acacia burkei* Woodland. Smaller communities invaded include those of *Euphorbia triangularis*, *E. pseudocactus*, *E. grandicornis*, *Acacia tortilis* and *Combretum gueinzii*.

Topography, climate, soils and encroachment: E. tirucalli spreads mainly on north, north-east, or north-west facing slopes in the driest areas of the Valley Region south of the Tugela River. Towards its eastern distributional limit in the Mapumulo district, however, the plant invades locally on mesoclines in the marginal Valley Region. One of the few areas north of the Tugela where *E. tirucalli* is encroaching on other communities, is below Middledrift, where the river swings to the south-east. Here tributary stream valleys have steep north-facing slopes similar to those on the southern side of the Tugela (Photo. 28). From its distribution, it thus appears that *E. tirucalli* spreads into relatively frost-free areas with a comparatively low rainfall, high

maximum temperatures and intense insolation on north-faeing slopes. The absence of *E. tirucalli* from the hot, but relatively moist, part of the Lower Valley Sub-region east of Maqumbi (in *Spirostachys-Acacia burkei* Woodland (section 6.3 (F)), is striking in comparison with its 'complete' dominance in the Maqumbi-Oqaqeni-Mpisi River area. Both these areas are at present sparsely populated, but have similar histories of intense disturbance.

Mechanisms of spread: The spread of *E. tirucalli* in the Valley Region is largely associated with disturbance of the primary vegetation and the resultant reduction in plant competition, but the plant is able to compete successfully with other vegetation, young plants becoming established in fairly dense scrub. Some observations in the lower Mooi River valley indicate that *E. tirucalli*, in a 3 ft high *Themeda triandra* var. *trachyspathea* grass field layer, is capable of withstanding considerable grass competition (see also Photo. 39).

The plant, being well adapted to vegetative propagation, is frequently planted by the Bantu as a hedge. Where plants are broken or chopped, they coppice freely. Regrowth is rapid when trees are overturned by wind or from the erosion of soils. Though goats occasionally browse the young shoots, their effects are negligible, browsed, stunted, low shrub forms being rare. The latex is highly irritating to the mucous membrane and eye of man and other animals.

Seed production is heavy, and distribution is by ejection from the explosive shattering of the capsules. On this aeeount, *E. tirucalli* spread tends to be more rapid downhill than uphill. Foci of spread are provided by *E. tirucalli* hedges around kraals some distance up ridges and eminenees. Gravitational effeets appear also in vegetative propagation. Transport of seeds or vegetative material by water is indicated by the occurrence of *E. tirucalli* along rivers and streams, the plant being eommon also in rocky riverine scrub along the banks of the Tugela.

Rate of spread: In comparison with the ratc of spread of other plants on secondary areas, sueh as *Acacia spp.*, that of *E. tirucalli* is slow, as shown in the initial scrub invasion of old lands by *Acacia tortilis* and its subsequent suppression by *E. tirucalli*. The relatively slow rate of spread is related to the method of seed dispersal discussed previously. Isolated clumps of *E. tirucalli* spread eentrifugally, linking up to form an ever increasing front of invasion. As is to be expected, *E. tirucalli* encroachment is considerably faster on to eleared than on to uncleared land, where there is eompetition from other plants. The slow spread into *relatively* undisturbed vegetation is shown by the mixed composition of many *E. tirucalli* communities in the lower Mooi River valley. In the lower Buffalo River valley, where eneroachment might well be expected to have oecurred, there is no evidence of invasion, explieable by the absence of planted eentres of distribution. The rate of spread is thus primarily a function of its distribution by man.

Community status and origin: In diseussing *E. tirucalli* Succulent Scrub, West (1951) coneludes:

'It is probable that over most of the area covered by this community the Euphorbia has attained dominanee beeause of the peculiarities of the local climate, that the community forms part of the climax and should be regarded as a consociation.

'On the other hand a suspicion that in some localities the eommunity is developmental and represents a very persistent or sub-climax stage of the seeondary sueeession is engendered by its patchy nature and the very abrupt transitions from patches of the *Euphorbia* dominated community to typieal Semi-deciduous Bush.'

In the present account, it is considered that the present widespread distribution of *E. tirucalli* is secondary.

An hypothesis that aecounts for the recent spread of *E. tirucalli* suggests that the plant is in fact an *alien* species brought down by the Bantu in their migrations from the north in the fifteenth and sixteenth eenturies (see Chapter 4). (I am indebted to Professor A. W. Bayer for the original suggestion.) The extent to which *E. tirucalli* is planted and has been spread over the hotter and drier parts of the world supplies evidence for the hypothesis. The plant is widely grown in the tropics and subtropics of the Old World (Howes, 1946). It was introdueed and in general use as a hedge plant in India before 1679, and was introduced long ago to Ceylon, Mauritius, Hong Kong, Formosa and other parts of the world, 'far removed from its original habitat' (White, Dyer and Sloane, 1941). Following the introduction of the plant to the Natal area, there was probably a considerable period of slow distribution by the Bantu. This has been steadily increasing with the increase in Bantu population (Chapter 4). The rate at which the species spreads has increased with the seve[illegible] erosion of the soil and destruction of vegetat[illegible] the middle of the last century. The success of the [illegible] has been such that with increase in popu[illegible] and vegetative material, *E. tirucalli* [illegible] invading relatively undisturbed vegetati[illegible] the rôle of a climax species.

Economic aspects: The present [illegible]

E. tirucalli Succulent Scrub represents waste veld, unless some use for the plant can be found. Present evidence suggests that *E. tirucalli* is a potential dominant over almost the whole of the Valley Region south of the Tugela, apart from much of the Weenen basin with its low minimum temperatures on the flat valley floors. It is important, therefore, that the spread of *E. tirucalli* be halted. This is a relatively slow process and grasses could rapidly be established to serve as competitors.

6.3 Dry Valley Scrub and Savanna

The Dry Valley Scrub and Savanna in the hotter and drier areas of the Valley Region is a complex vegetation upon a rugged topography (Photos. 27, 28). The principal trees are *Acacia tortilis*, *Boscia albitrunca*, *Combretum apiculatum*, *Euclea schimperi*, *Olea africana*, *Schotia brachypetala* and *Spirostachys africana*. There is a general gradient in the vegetation from taller woodland and savanna types in the eastern Valley Region, to shorter and more scrubby types in the western inland areas. There is a general zonation of plant communities, with the most xerophytic occurring on the Valley bottom and on the steep north-facing slopes south of the Tugela (Map 1).

The complexity of the Dry Valley Scrub and Savanna has been enhanced by severe disturbance within the last hundred years (Chapter 4), and today secondary plant communities occur over wide areas. Should present biotic pressures and soil erosion be maintained for much longer, only the most xerophytic plant communities will survive.

The following abbreviations are used in the descriptions of the various plant communities:

- LX = Driest, lowest altitudes along the Valley bottom and lower Valley slopes
- UM = Moister, upper slopes along the Valley sides
- M = Locally moister or more mesic situations and in bush clumps
- D = Species typical of drier areas of Valley Region
- O = Species occurring also in open, non-shade situations
- LTV = Lower Valley Sub-region east of Buffalo-Tugela confluence
- ELTV = Eastern part of Lower Valley Sub-region
- ITV = Interior Valley Sub-region west of Buffalo-Tugela confluence
- EITV = Eastern part of Interior Valley Sub-region

(a) ROCK OUTCROP SCRUB

Small communities, dominated by the following species, occur on rock outcrops in the Dry Valley Scrub and Savanna vegetation:

Croton gratissimus	F. petersi
Ficus ingens	F. soldanella
F. sonderi	F. burtt davyi
F. pretoriae	F. burkei

The characteristic, silvery-leaved, open scrub of *C. gratissimus*, 5 to 12 ft high, occurs on a variety of rock outcrops. These communities are not common in the Lower Valley Sub-region. In the lower Mooi River valley, associated species are *Euphorbia evansii* and *Ficus spp.*

F. ingens and *F. sonderi* communities are described in Chapter 5.

F. pretoriae, *F. ingens*, *F. sonderi* and *F. soldanella* are common on sandstone outcrops, forming open communities from 15 to over 30 ft in height. Frequent associated species are shrubs and small trees, up to 15 ft high, of *Vepris undulata* and *V. reflexa*.

Trees, up to 30 ft high, of *F. petersii*, *F. burtt davyi* and *F. burkei* are occasional in the Valley vegetation, occurring chiefly on south-facing slopes.

Under the dry climate of the Valley Region there is little successional development of these *Ficus* communities. Where rocks are broken on south-facing slopes, a mesophytic scrub with many species of the Marginal and Transitional Dry Valley vegetation may develop (section 6.4).

(b) COMBRETUM APICULATUM TREE VELD

Distribution and general ecology: Deciduous *C. apiculatum* Tree Veld is one of the principal communities of the Dry Valley Scrub and Savanna, covering 210 square miles of the Tugela Basin (Map 1, Photos. 27, 28, 40–42).

It occurs on shallow, stony soils on steep north-facing slopes in the hottest, driest, most rugged and inaccessible areas of the Valley Region. The community occurs most frequently on skeletal soils derived from formations of the Archaean Basement Complex and from the Insuzi Series of the Dominion Reef System. Further inland, at Tugela Ferry, Keat's Drift, Nkasine and in parts of the lower Buffalo River valley, the consociation occurs also on shallow soils derived from dolerite, Dwyka and Lower Ecca series of the Karroo System. Because of cold air drainage, frosts are rare. The mean annual rainfall is between 600 mm. and 700 mm.

The altitudinal range of *C. apiculatum* Tree Veld is from 1,000 to 3,000 ft. Westwards, the community interdigitates with the closely related, but more xerophytic

and frost-tolerant, Semi-deciduous Bush Association (see (C)). In the eastern half of its distribution, *C. apiculatum* Tree Veld has been invaded by *E. tirucalli* Succulent Scrub, or grades into *Spirostachys* Valley Woodland on the deeper soils along the bottom of the Valley Region.

Physiognomy and structure: The upper tree stratum is composed of scattered, deciduous trees, 20 to over 25 ft high, mainly of *C. apiculatum*. Below is an open to fairly dense, deciduous, short tree stratum from 10 to 18 ft high, mainly of *Acacia spp.*, and a scattered shrub and small tree layer, 3 to 10 ft high. Between the trees and shrubs is an open grass field layer, which in rare primary types found mainly in the sparsely populated areas of the lower Buffalo River valley, is up to 4 ft high (Photo. 41). Climbers are infrequent. Epiphytes, other than mosses and lichens, are absent and parasites are occasional.

In the Lower Valley Sub-region and in parts of the lower Buffalo River valley, there are scrub forms of the community with bush clumps developed around the tallest trees.

Composition: Frequent to abundant species of the open, tall tree stratum, from 20 to over 25 ft high, are:

Combretum apiculatum	Spirostachys africana (LX)
Olea africana	Acacia robusta (LX)
Schotia brachypetala	Sclerocarya birrea

Occasional species are:

Sideroxylon inerme (M)	Euphorbia ingens
Phyllogeiton zeyheri (M)	Ziziphus mucronata (M)

Species of the denser short tree stratum, from 10 to 18 ft high, include a number of plants from the upper stratum in the shorter Semi-deciduous Bush, but which in *C. apiculatum* Tree Veld seldom reach the upper tall tree layer. Frequent to abundant species of the short tree layer are:

Acacia gerrardii	Euclea crispa (UM)
Heeria paniculosa	Vitex rehmannii
Acacia nilotica	Pseudocassine transvaalensis (LX)
A. caffra (M)	
A. tortilis (LX)	Premna mooiensis (LX)
Rhus pentheri	Boscia albitrunca (LX)
Tarchonanthus minor	Pappea capensis (LX)
Euphorbia tirucalli	Dichrostachys cinerea
Euclea schimperi (LX)	Cussonia spicata
	Dombeya rotundifolia (M)

Occasional species include:

Clerodendrum glabrum (UM)	Maerua angolensis (LX)
	Cussonia natalensis (UM)
Erythrina lysistemon (M)	Commiphora neglecta (LX)
Hippobromus pauciflorus (M)	Gardenia cornuta (LX)
	Vepris undulata
Rhus rehmanniana (UM)	Strychnos spinosa (LXLTV)
	S. innocua (LXLTV)

Typical species of the shrub and small tree stratum, up to 10 ft high, are:

Maytenus cymosus (typical form)	Euphorbia grandicornis (LXLTV)
M. cymosus (forma = DE 1253)	Croton menyhartii (LXLTV)
M. senegalensis	C. gratissimus
Brachylaena elliptica	Acokanthera oppositifolia
Aloe marlothii	Rhus dentata
A. spectabilis	Pavetta assimilis
Vangueria infausta	Diospyros lycioides (UM)
Grewia monticola	Acacia senegal (LTV)
G. flava	Calpurnia subdecandra (M)
Ehretia rigida	Grewia occidentalis (M)
Euphorbia pseudocactus (LXITV)	

Typical grasses of the heliophilous field layer include:

Themeda triandra var. trachyspathea	Chloris gayana
	Urochloa mosambicensis (LX)
Heteropogon contortus	
Aristida barbicollis	Digitaria macroglossa
Eragrostis superba	D. pentzii
Rhynchelytrum setifolium	D. longiflora
R. repens	Eragrostis chloromelas
Sporobolus fimbriatus	Perotis patens (UMLTV)
S. smutsii (LX)	Trichoneura grandiglumis (UMLTV)
Cymbopogon plurinodis	
Bothriochloa insculpta	Enneapogon cenchroides
	E. scoparius

Climax grasses are represented by *T. triandra* and *Heteropogon contortus*. Primary pioneers of the xerosere, often dominant on the shallow soils or as a result of disturbance, are *Aristida barbicollis* and Rhynchelytrum *setifolium* (see (C)). *Bothriochloa insculpta* is often dominant on black, turfy soils derived from dolerite. Under shade, the principal grasses are *Panicum maximum* and *P. deustum*.

Xerompluis rudis is a typical field layer shrub under trees, exceeding 3 ft in the absence of browsing. Other shade tolerant field layer species include:

Peristrophe natalensis	Zinnia multiflora
Hypoestes verticillaris	Barleria obtusa
Lippia javanica (O)	Acanthaceae spp.

(see also (C), field layer in Semi-deciduous Bush)

Climbers are not abundant, occurring mainly in bush clumps, or occasionally as sprawling shrubs. Typical species include:

Jasminum multipartitum	Ipomoea albivenia
J. breviflorum	Sarcostemma viminale
Acacia schweinfurthii	Cissus quadrangularis
Ximenia caffra	Diospyros simii (LTV)

Parasites found occasionally on trees and shrubs are:

Loranthus dregei	Viscum rotundifolium
L. zeyheri	

Discussion: C. apiculatum Tree Veld is one of the principal climax consociations of the [illegible] and Savanna. The climax community is a savanna with a well-developed herbaceous ground layer, in which, previous to the [illegible]

grass fires may have occurred frequently. Although heavily overgrazed, *C. apiculatum* Tree Veld is protected against severe disturbance by inaccessibility.

Much of the area formerly covered by *C. apiculatum* Tree Veld has been invaded by *Euphorbia tirucalli*, *E. grandicornis* and *E. pseudocactus* (section 6.2). East of Middledrift around the Mpisi River, numerous tall *C. apiculatum* trees in dense *E. tirucalli* Succulent Scrub are regarded as relics of former *C. apiculatum* Tree Veld.

(c) SEMI-DECIDUOUS BUSH (ACACIA-BOSCIA-OLEA-SCHOTIA SCRUB)

Distribution and general ecology: Semi-deciduous Bush is the principal association of hot, dry areas in the Interior Valley Sub-region, covering about 450 square miles (Map 1, Photos. 43–45). This bush, or scrub, is surrounded mainly by the Interior *Acacia karroo-A. nilotica* Thorn Veld. Eastwards it adjoins *Combretum* apiculatum Tree Veld, *Spirostachys* Valley Woodland and *Euphorbia tirucalli* Succulent Scrub.

The altitudinal range of Semi-deciduous Bush is from 2,000 to 3,800 ft. The topography is rugged, rocky dolerite hills and sandstone terraces dominating the landscape. The mean annual rainfall is from 601 to 700 mm. Maximum temperatures up to 42·8° C have been recorded, and a minimum temperature of −6·7° C has been measured at Weenen. On flat areas along the bottoms of valleys, such as around Weenen, moderately severe to severe frosts are experienced. Light frosts occur on hillsides. The Semi-deciduous Bush experiences the greatest ranges of temperature in the Tugela Basin (Chapter 2).

On hillsides, soils are stony, skeletal types derived from dolerite, Ecca shales and sandstones. Shales are exposed over wide areas by severe soil erosion. Along the bottoms of the valleys and often between the rounded dolerite rocks on hills, the soils are deep, neutral to alkaline, arid types (Chapter 3).

Physiognomy and structure: Most species composing the Semi-deciduous Bush are deciduous during the dry winter, but evergreen species, such as *Olea africana*, *Boscia albitrunca*, *Euclea crispa* and *E. schimperi*, are prominent. Succulent plants, mainly *Euphorbia spp.* and *Aloe spp.*, occur on shallow and eroded soils.

Semi-deciduous Bush varies from a scrub to a savanna. Scrub, with numerous bush clumps and thickets, predominates, savanna rarely covering any extensive area. Scrub occurs mainly on rocky hillsides, whereas on the cultivable deep soils along the valley floors there is open relic and secondary vegetation. Prior to the destruction of the valley floor vegetation, savanna forms were probably present.

The upper tree layers are shorter than in communities found further east in the Valley Region. The discontinuous upper tall tree stratum rarely exceeds 25 ft, being generally from 18 to 25 ft high. The tallest trees are found in the centres of old bush clumps. The short tree layer, dense and giving the Semi-deciduous Bush its scrub character, is usually from 10 to 15 ft high. The shrub and small tree layer, from 3 to 6 ft high, is often dense, especially in incipient bush clumps. A grass field layer occurs between the shrubs and trees. A shade-tolerant, herbaceous and sub-shrubby stratum is developed in the scrub. Secondary field layer socies predominate as a result of grazing, browsing and trampling. Climbers are frequent in bush clumps and in dense scrub. Angiosperm epiphytes are absent. Parasites are occasional on trees and shrubs.

Composition: Frequent to abundant species in the tall tree stratum, 18 to 25 ft high, are:

Schotia brachypetala	Acacia robusta
Olea africana	Cussonia spicata
Pseudocassine transvaalensis	Euphorbia ingens
Vitex rehmannii	Pappea capensis
Heeria paniculosa	Ziziphus mucronata

Occasional or local species include:

Phyllogeiton zeyheri	Ficus pretoriae
Euphorbia triangularis	F. petersii
Sideroxylon inerme (M)	Apodytes dimidiata (M)
Spirostachys africana (LX)	

Frequent to abundant species of the short tree layer, 10 to 15 ft high, are:

Acacia tortilis	Tarchonanthus minor
A. nilotica	Dombeya cymosa
Rhus pentheri	Aloe marlothii
Boscia albitrunca	A. spectabilis
Euclea crispa	Dichrostachys cinerea
E. schimperi	Buddleia saligna
Acacia caffra (M)	Vangueria infausta
Premna mooiensis	Hippobromus pauciflorus
Euphorbia tirucalli	

Occasional or locally abundant species of the short tree layer are:

Acacia karroo	Aloe rupestris
A. gerrardii	Maerua angolensis (LX)
Clerodendrum glabrum	M. rosmarinoides (LX)
Ptaeroxylon obliquum	Pavetta assimilis
Vepris reflexa	Scolopia zeyheri
Rhus rehmanniana	Combretum erythrophyllum (M)
Erythrina lysistemon	Dombeya rotundifolia
Canthium mundtianum	Austromimusops dispar (M)
Pachystigma macrocalyx	Ficus ingens
Commiphora neglecta (LX)	F. sonderi
C. harveyi (M)	

Photo. 29. Hydrosere showing: (*a*) Lower fringing zone of *Phragmites communis*, *Cyperus marginatus*, *Miscanthidium junceum* and *Salix woodii* on sand banks. (*b*) Scattered trees of *Combretum erythrophyllum* and *Acacia karroo* forming initial stages of development of Riverine Woodland. (*c*) *Cynodon dactylon*, with taller grasses locally on exposed, dry, sand banks, where they form initial stages of deflection of hydrosere to grassland. (*d*) Rocky river banks with little vegetation. Confluence of Onderbroek and Tugela Rivers below Colenso, Interior Tugela Valley. Winter low flow of river.

Photo. 30. Disturbance of hydrosere: (*a*) *Phragmites communis* fringe localised and almost completely destroyed. (*b*) Short *Cynodon dactylon* Grassland, continuously heavily grazed, trampled, on eroded sand banks. (*c*) Bare, rocky river banks with remnants of *Spirostachys* Valley Woodland terminating abruptly above river. (*d*) Occasional riverine trees of *Ficus sycamorus* and *Trichilia emetica* in distance. Winter low flow of Tugela River. Lower Tugela Valley. Middledrift.

Photo. 31. Ruderal community of Burweed, *Xanthium pungens,* on island sand bank of Tugela River. Lower Tugela Valley. Middledrift. 28/5/57.

Photo. 32. Ficus [illegible] Woodland on island of Tugela River. The woody climber, *Dalbergia* [illegible] present in background. Lower Tugela Valley. Middledrift.

Photo. 33. Aloe marlothii Consociation on dolerite outcrop. Grasses have recently been burnt, showing rocky character of the habitat. The xerophytic ferns, *Pellaea calomelanos* and *Notholaena eckloniana* are abundant amongst the rocks. Six miles from Dundee on Helpmekaar road.

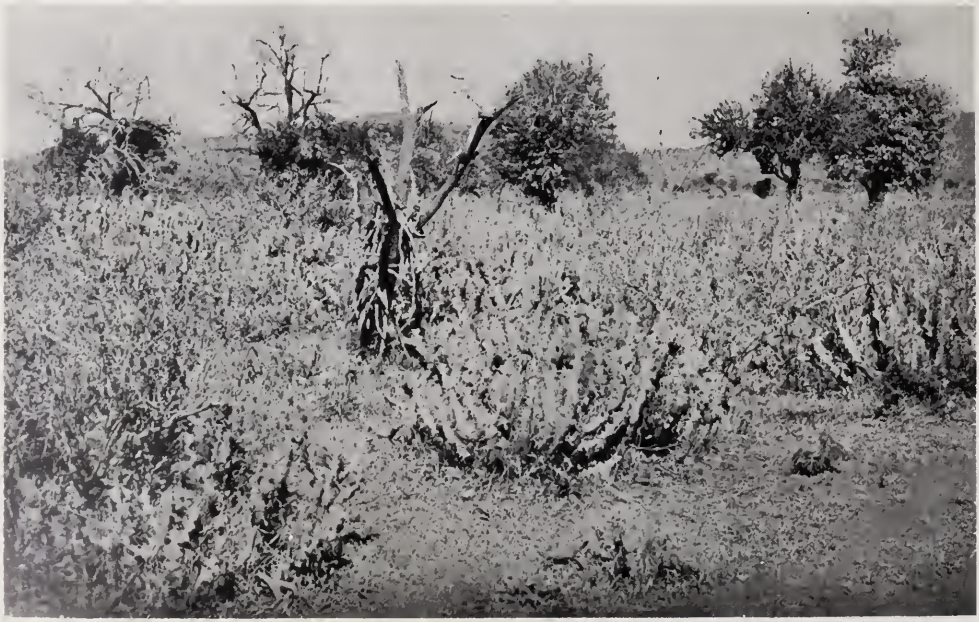


Photo. 34. Secondary ***Euphorbia grandicornis*** Consocies in Relic *Spirostachys* Valley Woodland. *Croton menyhartii* shrubs common. The succulent climber, *Cissus quardrangularis*, on dead tree in centre. Note poor cover of secondary grass stratum of *Urochloa mosambicensis*.

Vepris undulata	F. soldanella
Euphorbia evansii	Heteromorpha trifoliata
Fagara capensis (M)	(M)

The short tree layer includes numbers of secondary plants, such as *Acacia spp.* and *Dichrostachys cinerea.*

Frequent to abundant shrubs and small trees, from 3 to 6 ft high, are:

Maytenus cymosus (typical form)	Euphorbia pseudocactus (LX)
M. cymosus (forma DE 1253)	Calpurnia subdecandra (M)
	Brachylaena ilicifolia
	B. elliptica

Occasional or local species include:

Ehretia rigida	Grewia monticola
Acokanthera oppositifolia	G. flava
Grewia occidentalis	Maytenus undatus
Diospyros lycioides	Ochna natalitia
Croton gratissimus	Greyia sutherlandii (M)
Rhus dentata	Crotalaria monteroi

Under present-day conditions, the heliophilous grass field layer is composed mainly of subclimax early xerosere and secondary species. Broad-leaved and stoloniferous grasses are more prominent than in grasslands of the Interior Basins and Uplands Regions (see Chapter 7).

Climax grasses of the field layer are only locally abundant. Tufted, and from 2 to 3·5 ft high, they are represented by:

Themeda triandra var. trachyspathea	Chloris gayana
	Bothriochloa insculpta
Heteropogon contortus	Setaria woodii
Cymbopogon plurinodis	

B. insculpta and *S. woodii* are typical of heavy, black dolerite soils.

In shade *Panicum maximum* and *P. deustum* are dominant.

The principal subclimax grasses, due to grazing, are low-growing and less than 2·5 ft high. They are:

Eragrostis superba	Sporobolus fimbriatus
E. chloromelas	S. smutsii
Digitaria pentzii	Urochloa mosambicensis
D. macroglossa	

The unpalatable climax species, *Cymbopogon plurinodis*, often persists in subclimax stages. Subclimax grasses of *Eragrostis spp.* and *Digitaria spp.* occur also as associated species in the climax grass field layer.

Typical grasses of the xerosere and secondary sere are:

Aristida barbicollis	Rhynchelytrum repens
A. curvata	Chloris virgata
Cynodon dactylon	C. pycnothrix
Bothriochloa insculpta	Tragus berteronianus
Rhynchelytrum setifolium	Setaria verticillata

Species in the right column are common on old cultivation.

Low shrubs increase because of overstocking and destruction of the grass, and in scrub are dominant in the field layer. Numerous herbaceous and semi-woody species, especially of Acanthaceae such as *Blepharis natalensis*, are also found. *Xeromphis rudis* and *Lippia javanica* are typical low shrubs under trees, persisting to form open shrub societies when the tree and shrub strata are destroyed (see (H)). Heavily browsed *Xeromphis rudis* cushions are characteristic of heavily stocked areas.

Blepharis natalensis is commonly a dominant secondary field layer species, up to 12 ins high.

A shade-tolerant herbaceous field layer in scrub is disturbed by browsing and trampling by stock, and is often absent on this account.

Frequent to abundant low shrubs, semi-shrubs and herbs are:

Xeromphis rudis (O)	Peristrophe natalensis (O)
Lippia javanica (O)	Hypoestes verticillaris (O)
Asparagus spp. (O)	Justicia flava
Blepharis natalensis (O)	Ruellia patula (O)
Barleria obtusa	

Occasional or locally abundant species include:

Lasiocorys capensis (O)	Crossandra greenstockii
Aster filifolius (O)	Leucas glabrata
Lycium sp. (= DE2061) (O)	Nautochilus labiatus (M)
	Sanseviera thyrsiflora
Teucrium riparium	Tagetes minuta (O)
Monechma debile	Trianthema transvaalensis
Chaetacanthus setiger (O)	Zinnia multiflora (O)
Achyropsis leptostachya	Acanthaceae spp.
Achyranthes aspera	Commicarpus plumbagineus
Bidens pilosa (O)	

Common ferns growing in the shelter of rocks and bush clumps are *Pellaea calomelanos* and *Notholaena eckloniana.*

Locally frequent succulent species on bare, eroded soils and in an open field layer are:

Kalanchoe rotundifolia	Aloe mudenensis
Cotyledon orbiculata	Euphorbia rhombifolia

Geophytes are not common, but on deep soils along the bottoms of some of the valleys, *Bulbine narcissifolia* and *Crinum macowanii* may form small societies.

Climbers are frequent in bush clumps and in scrub, especially on mesoclines and along rocky streambanks. Typical woody climbers are:

Asparagus falcatus	Acacia schweinfurthii
Jasminum multipartitum	Dalbergia obovat..
J. breviflorum	Plumbago capensis
Capparis transvaalensis	Ximenia caffra
Clematis brachiata	Helinus integr..
Rhoicissus tridentata	Rhyncho..

Succulent or semi-succulent climbers:

Sarcostemma viminale	Cissus ..
Senecio brachypodus	C. spp.
S. pleistocephalus	Cyphostemma ..
	Ipomoea ..

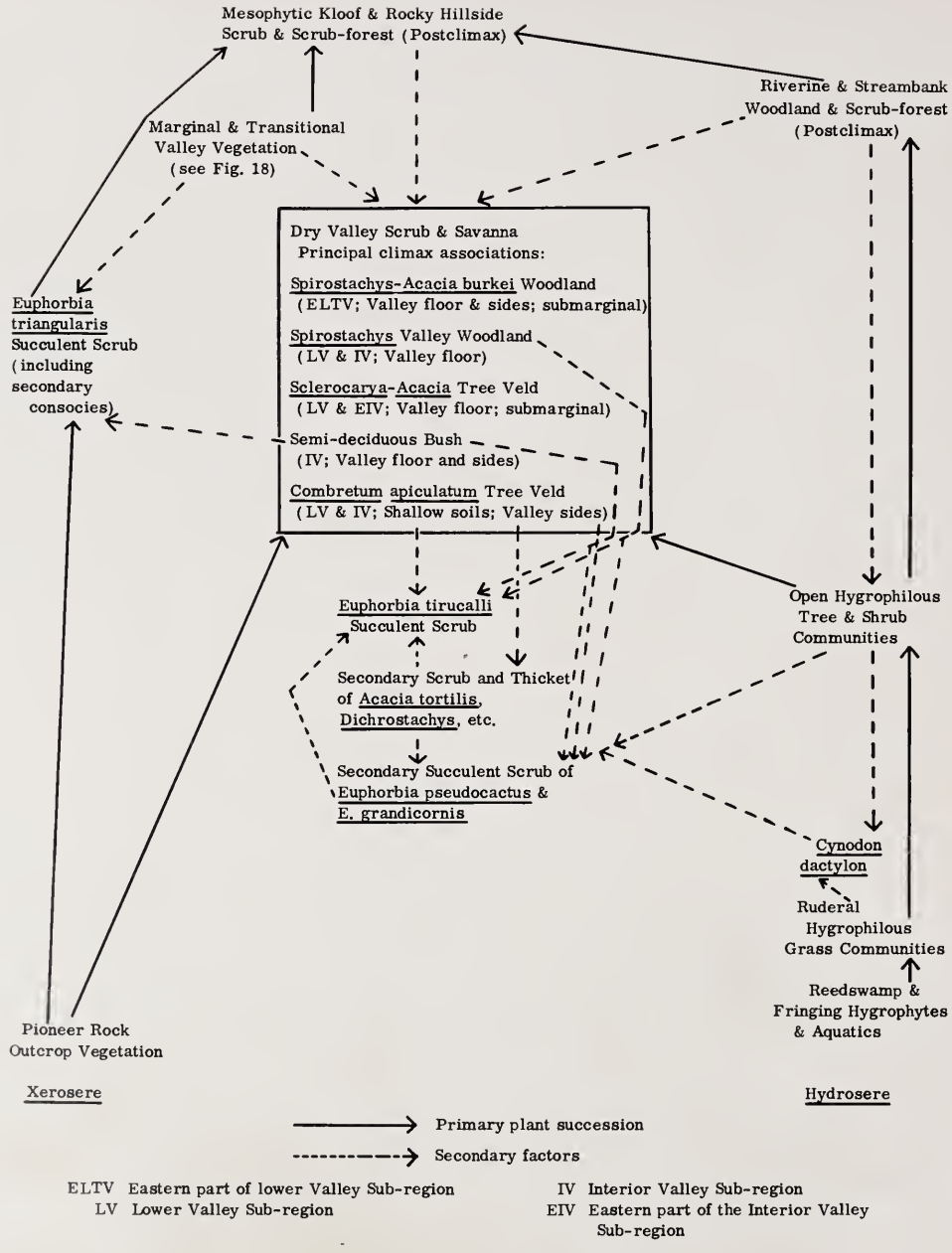

Mesophytic Kloof & Rocky Hillside Scrub & Scrub-forest (Postclimax)
Riverine & Streambank Woodland & Scrub-forest (Postclimax)
Marginal & Transitional Valley Vegetation (see Fig. 18)
Dry Valley Scrub & Savanna
Principal climax associations:
Spirostachys-Acacia burkei Woodland (ELTV; Valley floor & sides; submarginal)
Spirostachys Valley Woodland (LV & IV; Valley floor)
Sclerocarya-Acacia Tree Veld (LV & EIV; Valley floor; submarginal)
Semi-deciduous Bush (IV; Valley floor and sides)
Combretum apiculatum Tree Veld (LV & IV; Shallow soils; Valley sides)
Euphorbia triangularis Succulent Scrub (including secondary consocies)
Euphorbia tirucalli Succulent Scrub
Secondary Scrub and Thicket of Acacia tortilis, Dichrostachys, etc.
Secondary Succulent Scrub of Euphorbia pseudocactus & E. grandicornis
Open Hygrophilous Tree & Shrub Communities
Cynodon dactylon
Ruderal Hygrophilous Grass Communities
Reedswamp & Fringing Hygrophytes & Aquatics
Pioneer Rock Outcrop Vegetation
Xerosere
Hydrosere
Primary plant succession
Secondary factors
ELTV Eastern part of lower Valley Sub-region
LV Lower Valley Sub-region
IV Interior Valley Sub-region
EIV Eastern part of the Interior Valley Sub-region

Fig. 17. Generalised Community Interrelations of Dry Valley Scrub and Savanna of Valley Region

Parasites that occur occasionally on trees and shrubs are:

Loranthus dregeii	Viscum rotundifolium
L. zeyheri	

Floristic variants: Three intergrading faciations of the Semi-deciduous Bush are found.

(i) A *Vitex rehmanni* Faciation occurs at higher altitudes and usually, but not always, forms the gradation from Semi-deciduous Bush to *Acacia karroo-A. nilotica* Thorn Veld (Photo. 45). It is characterised by a high relative abundance of:

Vitex rehmannii	Euclea schimperi
Euclea crispa	Acacia nilotica

Elements of this faciation occur in the western and lower Buffalo River valley *Combretum apiculatum* Tree Veld.

(ii) A *Boscia albitrunca* Faciation occurs mainly at the dry, lower altitudes, and is characterised by a high relative abundance of:

Boscia albitrunca	Olea africana
Schotia brachypetala	Acacia tortilis

Euphorbia pseudocactus may also be prominent in the shrub layer, forming secondary consocies when the tree and shrub layers are destroyed. Much of the Faciation is represented by open secondary communities along the valley floors. Elements of the *Boscia* Faciation appear in *Spirostachys* Valley Woodland and at the dry, lower altitudes of *Combretum apiculatum* Tree Veld.

(iii) An *Acacia robusta* Faciation on Middle Ecca sandstone soils of rocky hillsides occurs mainly in the lower Mooi River valley. Traces of the Faciation appear below Colenso. The Faciation is characterised by a high relative abundance of:

Acacia robusta	Ptaeroxylon obliquum
Euclea schimperi	Vepris undulata
Olea africana	Ficus pretoriae
Vepris reflexa	Aster filifolius

Discussion: The Semi-deciduous Bush, first described by West (1951), forms the climax community of most of the hot, dry areas of the Interior Valley Sub-region. It is a complex community showing considerable physiognomic and floristic variation due to the rugged topography and secondary causes.

Disturbance has completely altered the character of the Semi-deciduous Bush. Where population densities are highest along the valley floors with deep soils, the community has degenerated to an open vegetation of scattered relic trees and numerous secondary species (see (G), (H)). A grass field layer is absent and erosion is often so active that the top soil has disappeared and the underlying rock is exposed. Erosion is worst on the shales.

On rocky, dolerite hillsides disturbance may be less severe, resulting in an increase of trees and shrubs to form a dense scrub. The heliophilous grass field layer is replaced, if the degree of stocking allows, by a sparse, shade-tolerant layer of herbs and semi-shrubs.

In 1837 the Weenen district was selected by the Voortrekkers as one of their principal settlement areas, although most of Natal was at that time sparsely populated (Chapter 4). It is certainly improbable that shrewd observers of nature, such as the Voortrekkers, would have chosen an area which was highly eroded or showed the present scrub density and poor grass cover. A few farms, that have in recent years been conserved, together with isolated relics of primary vegetation on inaccessible koppies, directly indicate the former relatively high quality pastoral value and open character of the Semi-deciduous Bush.

(D) SCLEROCARYA-ACACIA TREE VELD

Distribution and general ecology: Covering approximately 50 square miles, *Sclerocarya-Acacia* Tree Veld is chiefly developed in the lower Valley Sub-region north of the Tugela River in the Middledrift area. Outliers occur in the Mfongosi and Jameson's Drift areas (Map 1, Photo. 27). It is probable that a small western outlier occurred at one time in the Gunjana area between Tugela Ferry and the Sundays River. Severe disturbance is now found on the flats in this locality (not shown on Map 1).

The altitudinal range of *Sclerocarya-Acacia* Tree Veld is from 800 to 2,000 ft. Climate conditions are intermediate between the hot, dry lower Valley Sub-region climate characteristic of *Spirostachys* Valley Woodland and *Combretum apiculatum* Tree Veld, and the moister marginal Valley Region climate of the *Acacia karroo-A. nilotica* Thorn Veld. Light frosts occur in the low-lying Middledrift area, while in the Mfongosi area there are occasional moderately severe ones. The mean annual rainfall is between 600 and 800 mm. (Chapter 2).

The Tree Veld occurs on flat and undulating topography in areas with deep soils or softly weathering metamorphic rocks. Soils are mainly alluvial or colluvial and from the Tugela Series (du Toit [illegible] of the Archaean Complex. Locally, soils may be d[illegible] dolerite, the Mfongosi Series, the D[illegible] Ecca Series. On rocky, shallow soils [illegible] grades into *Combretum apiculatum* Tree [illegible] altitudes, and into *Acacia karroo-A. nil[illegible]* at higher altitudes

Physiognomy and structure: The upper tall tree stratum, 20 to over 25 ft high, is generally open, with the trees well separated. *Sclerocarya birrea*, the dominant species, is often sparse as a result of secondary destruction. At higher altitudes *Acacia sieberiana* is an abundant species. The short tree stratum, from 10 to 18 ft high, is open under primary conditions, but under present-day conditions there is a secondary development of *Acacia spp.* Bush clumps are not common. A shrub and small tree layer, 4 to 8 ft high, is not well represented. The field layer is dominated by heliophilous grasses. Shade tolerant grasses, herbs and shrubs occur under trees. Climbers are occasionally found. Angiosperm epiphytes are absent; parasites are occasional on trees and shrubs.

Composition: Frequent to abundant species of the upper tall tree stratum, over 20 ft high, are:

Sclerocarya birrea	Cussonia spicata
Acacia sieberiana	

Occasional or local species are:

Ziziphus mucronata	Olea africana
Combretum apiculatum	Acacia robusta (LX)
Heeria paniculosa	Cussonia natalensis
Schotia brachypetala	Phyllogeiton zeyheri
Spirostachys africana (LX)	Trichilia emetica (M)
Euphorbia ingens	

Frequent to abundant species of the short tree stratum, from 10 to 18 ft high, are:

Acacia nilotica	Dichrostachys cinerea
A. tortilis	Rhus pentheri
A. gerrardii	Vangueria infausta
A. caffra (M)	

The high abundance of *A. nilotica*, *A. tortilis* and *Dichrostachys cinerea* is due to disturbance.

Occasional or local species are:

Acacia senegal (LXLTV)	Pachystigma macrocalyx
A. karroo (UM)	Rhus rehmanniana
Strychnos spinosa (LTV)	Scolopia zeyheri
S. innocua (LTV)	Euphorbia tirucalli (planted)
Tarchonanthus minor	Canthium mundtianum
Clerodendrum glabrum	Combretum gueinzii
Canthium inerme	Boscia albitrunca (LX)
Erythrina lysistemon	Dombeya rotundifolia (M)
Hippobromus pauciflorus	Euclea schimperi (LX)
Euclea crispa	Commiphora harveyi (M)

Although *E. tirucalli* is planted as a hedge in this area, it does not here show any tendency to spread (section 6.2 (E)).

In the shrub and small tree layer, from 4 to 8 ft high, *Maytenus senegalensis*, *M. cymosus* (forma DE1253) and juvenile *Acacia spp.* are abundant as a result of disturbance.

Frequent to abundant species are:

Maytenus senegalensis	M. cymosus (typical form)
M. cymosus (forma DE1253)	Ehretia rigida

Occasional species are:

Grewia occidentalis	Acokanthera oppositifolia
Brachylaena elliptica	Rhus dentata
Diospyros lycioides	Caesalpinia decapetala (introduced)

As a result of past disturbance, secondary species predominate in the grass field layer. Only small, heavily grazed patches of the climax *Themeda triandra* grass field layer are found.

The principal grasses are:

Aristida barbicollis	Panicum maximum
Bothriochloa insculpta	Perotis patens
Chloris gayana	Rhynchelytrum repens
C. pycnothrix	R. setifolia
C. virgata	Setaria sphacelata
Cymbopogon plurinodis	S. woodii
Cynodon dactylon	Sporobolus fimbriatus
Digitaria macroglossa	S. pyramidalis
D. pentzii	S. smutsii (LX)
Eragrostis chloromelas	Themeda triandra var. trachyspathea
E. curvula	Tragus berteronianus
E. racemosa	Trichoneura grandiglumis
E. superba	Urochloa mosambicensis (LX)
Heteropogon contortus	

Occasional or locally abundant low shrubs and herbs of the shade tolerant field layer under trees are:

Xeromphis rudis (O)	Hypoestes verticillaris
Lippia javanica (O)	Barleria obtusa
Asparagus spp. (O)	Acanthaceae spp.
Peristrophe natalensis (O)	

Climbers which occur occasionally are:

Acacia schweinfurthii	Plumbago capensis
Capparis transvaalensis	Rhoicissus tridentata
Dalbergia armata	Diospyros simii
D. obovata	Ximenia caffra
Jasminum multipartitum	

Occasional succulent climbers are:

Cissus quadrangularis (LX)	Sarcostemma viminale
C. spp.	Senecio brachypodus
Cyphostemma spp.	S. pleistocephalus

Occasional parasites on trees and shrubs are:

Loranthus dregei	Viscum rotundifolium
L. zeyheri	

Discussion: Sclerocarya-Acacia Tree Veld represents the climax association on flat and undulating areas with deep soils and softly weathering rocks, in a climatic zone between the driest areas of the Valley Region and the moister, marginal *Acacia karroo-A. nilotica* Thorn Veld. These conditions are most extensively found in the Middledrift area and in the Mfongosi and Gunjana areas. South of the Tugela, steep and shallow soil conditions appear to be the principal factors preventing development of a *Sclerocarya-Acacia* association.

Secondary factors have modified the *Sclerocarya-Acacia* Tree Veld, but the disturbance is less, owing to

lower population densities and inaccessibility, than in Semi-deciduous Bush or *Spirostachys*-Valley Woodland. Secondary factors have resulted chiefly in a decrease in the tall tree (*S. birrea*) stratum, in an increase in the density of the short tree and shrub strata because of *Acacia spp.* encroachment, and in the replacement of climax grasses by secondary species. Sheet erosion is common but generally not severe. *Acacia tortilis*, co-dominant in the driest, lower areas of *Sclerocarya-Acacia* Tree Veld, is extending upwards, whereas the mesophytic tall tree species, *A. sieberiana*, is disappearing, only isolated relics still being found at the lower altitudes. This outward expansion of the more xerophytic species of the Dry Valley Scrub and Savanna is similar to their movement into the Interior *Acacia karroo-A. nilotica* Thorn Veld (section 6.4).

(E) SPIROSTACHYS VALLEY WOODLAND

Distribution and general ecology: The valley woodland dominated by *Spirostachys africana* occurs in the vicinity of the Tugela between Maqumbi and the Sundays River confluence, with extensions up the principal tributary river valleys only for short distances (Map 1, Photos. 28, 46, 47). The community covers approximately 90 square miles.

West of the Sundays-Tugela confluence to a few miles below Colenso, *S. africana* is generally small and stunted. In this section of the Tugela Valley, and for short distances up the Bushmans and Bloukrans River valleys, *S. africana* occurs frequently in the Semi-deciduous Bush ecotone to *Spirostachys* Valley Woodland. East of Middledrift in the Oqaqeni-Mambula area, there is a transition from xerophytic *Spirostachys* Valley Woodland to a more mesophytic *Spirostachys-Acacia burkei* Woodland.

Spirostachys Valley Woodland occurs in flat, hot areas, mainly between the Tugela and the steep, north-facing slopes south of the river. Absolute maximum temperatures are over 40° C. The mean annual rainfall is between 600 and 800 mm. Heavy valley mists and light frosts occur during winter (Chapter 2). Although the soils are severely eroded, they consist of a deep colluvium and alluvium, which may be classified as neutral to alkaline arid types (Chapter 3).

Physiognomy and structure: Because of heavy population densities along the floor of the Tugela Valley, *Spirostachys* Valley Woodland has been subjected to extremely heavy disturbance. The primary woodland has been almost entirely replaced by open, secondary vegetation composed of relic trees and secondary species. No other community in the Tugela Basin has changed so much from its original character as has *Spirostachys* Valley Woodland. For these reasons, secondary characters are included in the description to contrast with the primary structural and physiognomic characters now rarely found.

When not destroyed, trees in the deciduous, tall tree stratum, 25 ft or more high, are separated by slightly less than their crown diameter, forming a closed woodland, but as a result of disturbance, the upper stratum trees become widely separated.

In the lower, short tree layer, 10 to 18 ft high, the trees are well separated. Many species in the same stratum of the xerophytic *Boscia* Faciation of Semi-deciduous Bush appear frequently to abundantly. Under the prevailing secondary conditions, *Acacia tortilis* and other secondary species are prominent. In the shrub and small tree layer, 4 to 8 ft high, secondary succulent shrubs of *Euphorbia grandicornis* and *E. pseudocactus* have become dominant over extensive areas. Heavily browsed, stunted plants of *A. tortilis* are also abundant. It is probable that under primary conditions the shrub and small tree layer was sparse. *Themeda triandra* var. *trachyspathea* and other tall climax grasses, up to 4 ft high, are at present found only in the centres of spinescent *E. grandicornis* and *E. pseudocactus* clumps, out of reach of grazing animals. The secondary field layer is composed of heavily grazed or browsed, low-growing prostrate grasses such as *Urochloa mosambicensis* and weeds and small shrubs and sub-shrubs such as *Blepharis natalensis*. Eroding bare soil is exposed between individual plants of the field layer. The primary, shade tolerant field layer of sciophytic grasses, low shrubs and herbs is sparsely represented at present.

Climbers are occasional to frequent. The succulent climber, *Cissus quadrangularis* occurs abundantly, over trees or sprawling on the ground. Parasites on trees and shrubs are occasional. A feature of *Spirostachys* Valley Woodland (and *Spirostachys-Acacia burkei* Woodland) is the common occurrence east of Tugela Ferry, where frosts are not severe, of the large epiphytic orchid, *Ansellia gigantea*. Valley mists, densest at the bottom of the Valley Region, must play an important role in supplying the moisture requirements of this [illegible]

Composition: Spirostachys Valley [illegible] characterised by a high relative abu[illegible] phytic species, particularly succulent [illegible] species of the xerophytic *Boscia* [illegible] deciduous Bush.

Dominant and abundant species [illegible]

tall tree stratum are *Spirostachys africana* and *Acacia robusta*.

Occasional to frequent tall trees are:

Combretum apiculatum	Schotia brachypetala
Olea africana	Euphorbia ingens
Ziziphus mucronata	Phyllogeiton zeyheri (M)
Cussonia spicata	Trichilia emetica (MLTV)
Sclerocarya birrea	Kigelia pinnata (LTV)

The presence of *C. apiculatum* is associated with shallow soils.

Frequent to abundant species of the short tree layer are:

Acacia tortilis	Acacia nilotica
Euphorbia tirucalli	Commiphora neglecta
Boscia albitrunca	Dichrostachys cinerea
Euclea schimperi	Gardenia cornuta
Premna mooiensis	Heeria paniculosa
Pappea capensis	Maerua rosmarinoides
Pseudocassine transvaalensis	M. angolensis
Rhus pentheri	Strychnos spinosa
Tarchonanthus minor	S. innocua

The high relative abundance of *A. tortilis*, *E. tirucalli* and *D. cinerea* is due to secondary factors.

Occasional to frequent or locally abundant species are:

Dombeya cymosa	Commiphora harveyi (M)
Acacia gerrardii	Acacia karroo (M)
Buddleia saligna	Erythrina lysistemon (M)
Vitex rehmannii	Manilkara concolor (LTV)
Combretum gueinzii (MLTV)	Turraea floribunda (MLTV)
Clerodendrum glabrum (M)	Trema orientalis (M)
Chaetacme aristata (MLTV)	Aloe rupestris (M)

Frequent to abundant species of the shrub and small tree layer are:

Euphorbia grandicornis (LTV)	Croton menyhartii (LTV)
E. pseudocactus (ITV)	Maytenus cymosus (forma DE1253)

Occasional to frequent or locally abundant species are:

Maytenus cymosus (typical form)	Brachylaena elliptica
M. cymosus (forma DE958) (M)	Grewia monticola
M. senegalensis	G. occidentalis (M)
Ehretia rigida	Calpurnia subdecandra (M)
Vangueria infausta	Acokanthera oppositifolia
Aloe marlothii	Erythrococca natalensis (MLTV)
A. spectabilis	Diospyros scabrida (MLTV)
Brachylaena ilicifolia	

The principal grasses of the heliophilous field layer are:

Urochloa mosambicensis	Rhynchelytrum repens
Sporobolus fimbriatus	R. setifolia
S. smutsii	Eragrostis superba
S. pyramidalis	Chloris gayana
Digitaria pentzii	Cymbopogon plurinodis
D. macroglossa	Themeda triandra var. trachyspathea
Cynodon dactylon	Bothriochloa insculpta
Aristida barbicollis	Heteropogon contortus
Tragus berteronianus	

C. plurinodis, *T. triandra*, *B. insculpta* and *H. contortus*, all infrequent and localised, are dominants of the climax grass field layer, whereas the previous species are representative of secondary sub-climax and secondary seral stages (see also field layer in (C)).

Panicum maximum and *P. deustum* are found where disturbance is absent or light in shade.

The principal low shrubs, sub-shrubs and herbs of the shade tolerant field layer are:

Abutilon austro-africanum (LTV)	Cotyledon orbiculata (O)
Achyranthes aspera	Delosperma sp. (= DE1704)
Achyropsis leptostachya	Hypoestes verticillaris (O)
Asparagus spp. (O)	Justicia flava
Barleria elegans (O)	Kalanchoe rotundifolia
B. obtusifolia (O)	Leucas glabrata
Bidens pilosa (O)	Lippia javanica (O)
Blepharis integrifolia (LTV) (O)	Lycium sp. (O)
B. maderaspatensis (LTV) (O)	Monechma debile (O)
B. natalensis (O)	Peristrophe natalensis (O)
Bulbine narcissifolia (O)	Xeromphis rudis (O)
Ceratotheca triloba (O)	Ruellia patula (O)
Chaetacanthus setiger (O)	Sanseviera thyrsiflora
Commicarpus africanus	Tagetes minuta (O)
Crossandra greenstockii (O)	Trianthema transvaalensis (O)

(see also (C)), discussion of field layer of Semi-deciduous Bush). All these species increase as a result of light disturbance, but except for *Blepharis natalensis*, are destroyed by severe trampling and browsing. Bare ground is, therefore, common.

Occasional to frequent or locally abundant woody climbers are:

Acacia schweinfurthii	Plumbago capensis
Capparis transvaalensis	Rhoicissus tridentata
Dalbergia armata (M)	Diospyros simii (LTV)
D. obovata	Strophanthus gerrardii (LTV)
Jasminum multipartitum	Tecomaria capensis
J. breviflorum	
Ximenia caffra	

Frequent to abundant succulent and semi-succulent climbers are:

Cissus quadrangularis	Cyphostemma spp.
Cissus spp.	

Occasional to frequent succulent and semi-succulent climbers are:

Sarcostemma viminale	Senecio pleistocephalus
Senecio viminalis	Ipomoea albivenia
S. brachypodus	Azima tetracantha

The abundance of *Cissus quadrangularis* is associated with heavy disturbance. In many instances, the angular thick, heavy, leafless, succulent stems kill the supporting tree, especially light-demanding plants such as *Acacia spp.*

Occasional parasites on trees and shrubs are:

Loranthus dregei	Viscum rotundifolium
L. zeyheri	

The epiphyte, *Ansellia gigantea*, is fast disappearing because of utilisation for Bantu medicinal purposes and also because the supporting trees are destroyed.

Discussion: Spirostachys Valley Woodland represents the climax community on deep soils in the hottest and driest floor areas of the Valley Region. *Spirostachys* Valley Woodland and *Spirostachys-Acacia burkei* Woodland (see (F)) may be regarded as the most tropical types of Dry Valley Scrub and Savanna (compare Deciduous Tall Tree Savanna of Bayer (1938)).

As previously discussed, *Spirostachys* Valley Woodland has been almost completely reduced to an open, secondary community. Not only has this resulted in severe soil erosion and the disappearance of the former high quality grazing, but also in the loss of a most useful timber.

(F) SPIROSTACHYS-ACACIA BURKEI WOODLAND

Distribution and general ecology: Spirostachys-Acacia burkei Woodland covers a small area of approximately 20 square miles in the hot, but relatively moist eastern part of the Valley Region from Mandini to Maqumbi (Map 1, Photo. 48). It is the tallest association of the Dry Valley Scrub and Savanna, and is the southernmost distributional limit of *A. burkei*. Westwards the community is replaced by *Spirostachys* Valley Woodland which, although related by the dominance of *S. africana*, differs in its xerophytic species composition. In the western part of its distribution, *Spirostachys-A. burkei* Woodland has been invaded to a slight extent by *Euphorbia tirucalli* Succulent Scrub. *Spirostachys-Acacia burkei* Woodland is separated from the moist Coast Lowlands vegetation by a distinct zone of the Dry Coast *Acacia karroo-A. nilotica* Thorn Veld (Map 1).

The altitudinal range of *Spirostachys-A. burkei* Woodland is from 300 to 1,600 ft. The upper limits on the southern side of the Tugela Valley are from 200 to 500 ft below the rim of the Valley, the Association seldom extending across the Tugela on to the north bank. This Woodland is thus characteristic of the hottest, driest, north-facing slopes and Valley floor of the eastern Valley Region. The mean annual rainfall is probably between 800 and 1,000 mm., but the effectiveness of the rainfall must be greatly reduced by high temperatures and high evaporation rates. Light frosts occur occasionally along the bottom of the valley (Chapter 2).

Soils are either loose, sandy and derived from the Table Mountain Series, or compact and clayey, derived from the Dwyka Series and dolerite.

Physiognomy and structure: On sandy Table Mountain Series soils, *Acacia burkei* is dominant, forming a rather dense, tall woodland, with frequent thickets and bush clumps. Westwards, on gentle topography below Maqumbi, *A. burkei* forms a more open savanna woodland. On clayey Dwyka and dolerite soils, *Spirostachys africana* is dominant either in a woodland or in a dense, tall, secondary scrub over 20 ft high. Scrub formation results from exploitation of *S. africana* for timber, as well as from other forms of disturbance. Thicket formation by *S. africana* is common in *Spirostachys-A. burkei* Woodland, but not in the dry and severely disturbed *Spirostachys* Valley Woodland west of Oqaqeni.

The tall tree stratum, dominated by *S. africana* and *A. burkei*, is from 25 to 35 ft high. In the open to dense short tree layer, from 10 to 20 ft high, *A. gerrardii* and *Combretum gueinzii* are amongst the principal species. Secondary thickets of *Dichrostachys cinerea* and *Commiphora neglecta* occur locally. The shrub layer, from 6 to 10 ft high, is dense in bush clumps and in disturbed areas, with secondary thickets of species such as *Xeromphis obovata*. The heliophilous grass field layer, up to over 4 ft high, is dominated by *Themeda triandra* var. *trachyspathea* where undisturbed. On sandy Table Mountain Series soils there is often a subclimax grass field layer, less than 2 ft high, of *Eragrostis spp.*, *Digitaria spp.* and *Sporobolus spp.* In the shade of trees and shrubs the field layer is composed of herbaceous and sub-shrubby plants, especially Acanthaceae spp. Parasites occur occasionally on trees and shrubs. As in the *Spirostachys* Valley Woodland (see (E)), the epiphytic orchid, *Ansellia gigantea*, is common. Climbers are abundant in the numerous bush clumps.

Composition: In *Spirostachys-A. burkei* Woodland are many coast or local species that do not extend further westward into the driest areas of the Valley Region. Species occurring in the driest part of the Valley Region seldom extend into *Spirostachys-A. burkei* Woodland.

Dominant and frequent to abundant species of the tall tree layer are:

Spirostachys africana	Sideroxylon inerme
Acacia burkei	Acacia robusta

Occasional to frequent or locally abundant species:

Ziziphus mucronata	Apodytes d[illegible]
Schotia brachypetala	Trichi[illegible]
Cussonia spicata	Trema o[illegible]
Phyllogeiton zeyheri	Celt[illegible]
Sclerocarya birrea	[illegible]
Albizia adianthifolia	Cro[illegible]
Olea africana	Ant[illegible]
Turraea floribunda	Harpephyllum caffrum

Ekebergia capensis (M)
Sapium integerrimum
Ficus petersii (M)

The last seven species, and the strangler fig, *Ficus natalensis*, occur on streambanks and occasionally in bush clumps, becoming more frequent eastwards towards Mandini. *Olea africana* represents an eastward penetration of a xerophytic species typical of the driest areas of the Valley Region.

Frequent to abundant species of the short tree stratum are:

Acacia gerrardii
Combretum gueinzii
Acacia nilotica
Heteropyxis natalensis
Dichrostachys cinerea
Strychnos spinosa
Canthium inerme

Occasional to frequent or locally abundant species are:

Acacia caffra
A. karroo (M)
A. senegal
A. tortilis (D)
Allophylus melanocarpus (M)
Austromimusops dispar
Boscia albitrunca (D)
Buddleia saligna
Chaetacme aristata (M)
Clausena anisata (M)
Clerodendrum glabrum
Commiphora harveyi (M)
C. neglecta (D)
Cordia caffra
Dais cotinifolia (M)
Dombeya cymosa
D. rotundifolia
Dovyalis caffra
Drypetes arguta (M)
Erythrina lysistemon
Euclea schimperi
E. natalensis (M)
Euphorbia ingens
Fagara capensis
Ficus ingens
Gardenia cornuta
Heeria paniculosa
Heteromorpha trifoliata (M)
Hippobromus pauciflorus
Kraussia floribunda (M)
Maerua angolensis (D)
M. rosmarinoides
Manilkara concolor
Pappea capensis (D)
Pseudocassine transvaalensis (D)
Ptaeroxylon obliquum
Rhus pentheri (D)
R. rehmanniana
Rothmannia globosa (M)
Strychnos innocua
Schrebera alata
Scolopia zeyheri
Tarchonanthus minor
T. trilobus
Trimeria grandifolia (M)
Wrightia natalensis
Xylotheca kraussiana

Frequent to abundant shrubs and small trees are:

Ehretia rigida
Xeromphis obovata
Diospyros glandulifera
Vangueria infausta
Putterlickia verrucosa
Maytenus cymosus (typical form)
M. undatus
Grewia occidentalis
Calpurnia subdecandra (M)

Occasional to frequent or locally abundant species are:

Acokanthera oppositifolia
Aloe marlothii
A. spectabilis
Aloe rupestris (M)
Brachylaena elliptica
B. ilicifolia
Canthium ciliatum (M)
C. locuples
Crotalaria capensis
Diospyros scabrida
D. lycioides
Erythrococca natalensis (M)
Eugenia sp. (=DE1863)
Grewia monticola (D)
Maytenus mossambicensis (M)
M. senegalensis
Ochna natalitia
Pavetta lanceolata (M)
Phoenix reclinata (M)
Rhus simii
Tarenna barbetonensis

Typical grasses of the heliophilous field layer on rocky or shallow soils are:

Aristida barbicollis
Eragrostis racemosa
A. junciformis
Cynodon dactylon
Eragrostis capensis
Perotis patens
Trichoneura grandiglumis
Tragus berteronianus

The principal subclimax grasses on shallow soils or in grazed areas are:

Chloris gayana
Digitaria longiflora
D. macroglossa
D. pentzii
D. diagonalis
D. ternata
Enteropogon simplex
Eragrostis chapelieri
E. chloromelas
Eragrostis curvula
E. superba
Perotis patens
Sporobolus fimbriatus
Tricholaena monachne
Trichoneura grandiglumis
Urelytrum squarrosum
Urochloa mosambicensis (D)

Urochloa mosambicensis is characteristic of clayey soils in the driest areas. The principal climax grasses found extensively in undisturbed areas are:

Themeda triandra var. trachyspathea
Bothriochloa insculpta
Heteropogon contortus
Cymbopogon plurinodis
Hyparrhenia filipendula

together with the subclimax grasses as occasional species. Under shade, the principal grasses are:

Dactyloctenium aegyptium
D. australe
Digitaria longiflora
D. polevansii
Diplachne eleusine
Panicum maximum
Sacciolepis curvata
Setaria chevalieri (M)

The principal secondary grasses of heavily disturbed areas and old land sites are:

Chloris pycnothrix
C. virgata
Cynodon dactylon
Rhynchelytrum repens
Sporobolus capensis
S. pyramidalis
Pogonarthria squarrosa
Eragrostis ciliaris
Tragus berteronianus
Aristida barbicollis

Aristida junciformis invades at the upper altitudinal limits of *Spirostachys- A.burkei* Woodland (see Chapter 7).

Typical sedges in the heliophilous grass field layer on sandy soils are *Bulbostylis collina* and *Fimbristylis hispidula*.

Low shrubs are occasional in the heliophilous grass field layer. Species found are:

Lippia javanica
Crotalaria natalensis
Lantana rugosa
Pentanisia prunelloides

In addition to these low shrubs, several shade tolerant herbs and sub-shrubs may be found where there is disturbance.

In the shade herbaceous plants, especially Acanthacae, are abundant, with low shrubs and occasional xerophytic ferns. Species found include:

Abutilon galpinii
Achyranthes aspera
Aneilema dregeanum
Asparagus spp. (O)
Barleria elegans (O)
B. obtusa (O)
Blepharis integrifolia (O)
B. maderaspatensis (O)
Hypoestes verticillaris (O)
Justicia flava
Lantana rugosa (O)
Leucas glabrata
Lippia javanica (O)
Monechma debile
Ocimum suave
Pavetta gracilifolia (O)

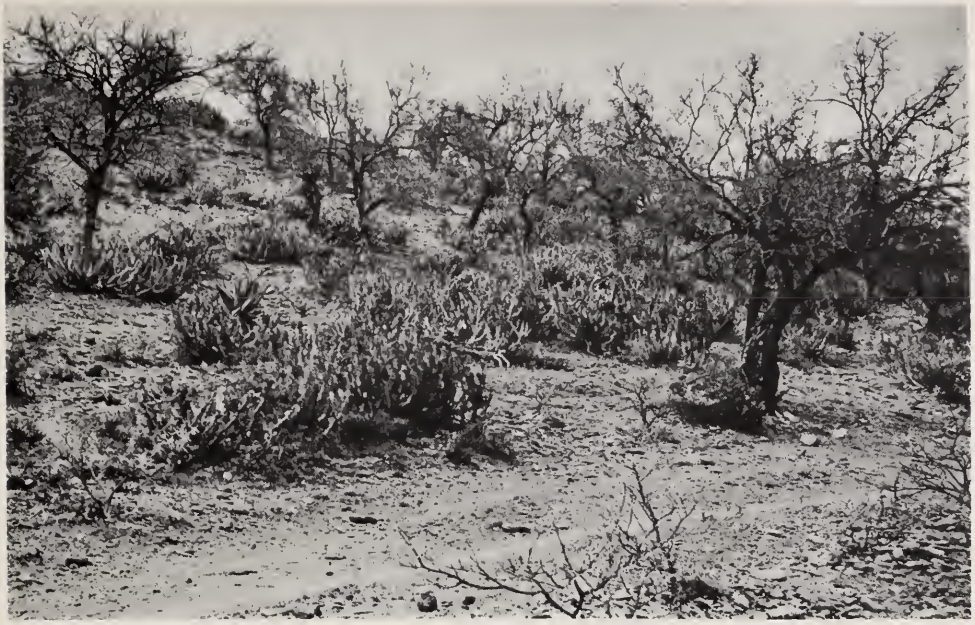


Photo. 35. Secondary *Euphorbia pseudocactus* development on severely eroded Nkandla geological series. Leafless trees of *Spirostachys africana* and small *Acacia tortilis* trees and shrubs, the latter heavily browsed by goats. Ngobevu, eastern Interior Tugela Valley.

Photo. 36. Euphorbia triangularis Consocies. Overstocking, and selective utilization by Bantu of *Acacia spp.* and other woody plants, are here favouring the spread of the succulent community and creating severe soil erosion. Lower Mooi River valley between Greytown and Keat's Drift.

Photo. 37. Spread of *Euphorbia tirucalli* on an abandoned Bantu kraal. The species was planted here originally as a hedge. Oqaqeni, Mapumulo district, Lower Tugela Valley.

Photo. 38. Suppression of heliophilous *Aloe marlothii* by dense *Euphorbia tirucalli* Scrub. Note dense litter here and development of Acanthaceae spp. field layer. Oqaqeni, Mapumulo district, Lower Tugela Valley.

Photo. 39. Grass development, due to protection from continuous overgrazing, in open, short, Mixed *Euphorbia tirucalli* Scrub. Keat's Drift, Lower Mooi River valley.

Photo. 40. Consociation of *Combretum opiculatum* Tree Veld on stony, shallow soils of steep, north facing slope in Amanziwayo River valley, Mfongosi area, Interior Tugela Valley (see also Photo. 27).

Photo. 41. Good *Themeda triandra* grass field layer cover in *Combretum apiculatum* Tree Veld in sparsely populated area of lower Buffalo River valley. Other trees shown are *Euclea crispa*, *Aloe marlothii*, *Rhus pentherii*, *Vitex rehmannii* and *Ziziphus mucronata.* Near Amangi-Buffalo River confluence, Hlalele area. Altitude 2,700 ft.

Photo. 42. Combretum apiculatum Tree Veld on steep, north facing slopes with shallow, stony soils and continuously overgrazed, poor, grass field layer. *Euphorbia tirucalli* encroachment at left, and *E.grandicornis* development on eroding soils at lower left. Middledrift area near Mambula River. Lower Tugela Valley.

Chaetacanthus setiger (O)	P. komghensis (O)
Commelina africana	Pellaea viridis (O)
Commicarpus africanus	Peristrophe natalensis (O)
Corchorus junodii (O)	Ruellia patula (O)
Crossandra greenstockii	Teucrium riparium
Hibiscus calyphyllus	Xeromphis rudis (O)

Occasional parasites on trees and shrubs are:

Loranthus dregeii	Viscum rotundifolium
L. zeyheri	V. viscosum

The epiphytic orchids, *Ansellia gigantea* and *Cyrtorchis arcuata*, are frequent, and *Rhipsalis baccifera* occurs in mesic situations. The dense valley mists supply a considerable amount of moisture for the growth of these epiphytes.

Climbers are common to abundant in bush clumps and in scrub. Woody climbers contributing to the density of the community are:

Abrus precatorius	Jasminum breviflorum
Acacia ataxacantha	J. multipartitum
A. schweinfurthii	J. stenolobum
Asparagus falcatus	Microglossa mespilifolia
Capparis transvaalensis	Pergularia daemia
C. tomentosa	Petopentia natalensis
Dalbergia armata	Plumbago capensis
D. obovata	Rhoicissus tridentata
Diospyros simii	Ruttya ovata
D. villosa	Scutia myrtina
Clematis brachiata	Sphaedamnocarpus pruriens
Entada spicata	Strophanthus gerrardii
E. wahlbergii	Tecomaria capensis
Gymnema sylvestre	Uvaria caffra
	Ximenia caffra

Herbaceous and semi-woody climbers are:

Cissampelos torulosa	Melothria cordata
Commicarpus pentandrus	Pupalia lappacea
C. africanus	Rhoicissus capensis (M)
Dalechampia capensis	Rhynchosia carribaea
Dioscorea cotinifolia	Smilax kraussiana
Helinus integrifolius	Tragia sp. (= DE1666)
Kedrostis foetidissima	

Succulent and semi-succulent climbers in the hottest areas on north facing slopes near the bottom of the valley, are:

Azima tetracantha (D)	Cissus spp.
Ceropegia plicata	Cynanchum tetrapterum
C. sandersonii	Sarcostemma viminale
C. setifera	Senecio brachypodus
C. undulata	S. pleistocephalus

Discussion: Although most of the area covered by *Spirostachys-A. burkei* Woodland is at present sparsely populated and subject to little disturbance, there is evidence to show that the area was formerly subject to much secondary influence. Old dongas, sheet eroded patches, paths, lands and kraal sites can be found overgrown by vegetation. The vegetation shows thickets dominated by single species changing into bush clumps composed of a variety of trees, shrubs and climbers; the tall *Themeda triandra* field layer invading secondary and subclimax grass stages, in turn being invaded by scrub; and an advanced secondary succession resulting in the present dense woodland. Historical evidence also indicates the former presence of a heavy Bantu population (see Chapter 4).

One of the principal factors contributing to the increase in woody vegetation is the absence of fire, the community being bounded on one side by the Tugela and on the other by sugar estates. In addition it is protected from fire by rugged topography. The narrow, winding area of the *Spirostachys-A. burkei* Association has evidently escaped fires caused by lightning for a considerable period. It is likely that no fires have occurred in this community for at least fifteen or twenty years.

During the middle of the last century elephants are known to have been present in considerable numbers in the lower Tugela Valley (Duff, cited Bulpin, 1952). The effects of these animals and of other indigenous herbivores, would have prevented development of a dense vegetation.

(G) RELIC TREE COMMUNITIES

One of the most distinctive and extensive 'communities' found in heavily populated and severely disturbed areas of the Valley Region, consists of isolated, relic trees of the former primary community, persisting among characteristically secondary species (Photos. 47, 49, 67–70). The communities are typical of old cultivation and heavily disturbed areas near Bantu habitations. The Relic Tree Communities are continuous over wide areas. Soils are highly eroded and subsoil or the underlying rock is exposed.

Although almost any tree species may be left as a relic of the former community, the principal species are:

Acacia robusta	Olea africana
Boscia albitrunca	Pseudocassine transvaalensis
Cussonia spicata	Premna mooiensis
Combretum apiculatum	Rhus pentheri
Euclea schimperi	Schotia brachypetala
Euphorbia ingens	Spirostachys africana
E. triangularis	Vitex rehmanni
Heeria paniculosa	

Trees such as *Boscia albitrunca*, one of the characteristic relic tree species, may be left by the Bantu for traditional reasons. In other instances trees may be left to provide shade for workers in the fields or as vantage points from which to chase birds away from crops. Some plants, such as *Euphorbia spp.*, are left because they possess an irritant latex which makes them dangerous to handle, or because they are unsuitable for timber or firewood.

Lower strata of the Relic Communities are composed chiefly of secondary species (see (H)), together with relics of the former community. Typical secondary species in the open or dense shrub layer, 3 to 10 ft high, are:

Acacia tortilis	Euphorbia grandicornis (LTV)
Croton menyhartii (LTV)	E. pseudocactus (ITV)
Dichrostachys cinerea	E. tirucalli

In the sparse field layer are annual weeds, low shrubs and sub-shrubs such as:

Xeromphis rudis	Lasiocorys capensis
Blepharis natalensis	Asparagus spp.
Lippia javanica	Peristrophe natalensis

Urochloa mosambicensis is a dominant of the grass stratum when this is present. Geophytes such as *Bulbine narcissifolia*, *Ammocharis falcata* and *Crinum macowanii* are on deep soils along the bottoms of the valleys.

(H) SECONDARY COMMUNITIES

Secondary Communities are abundant in the Dry Valley Scrub and Savanna. They are composed principally of trees or shrubs capable of withstanding the severe biotic pressures on the vegetation. (Secondary succulent communities have already been discussed in section 6.3.)

Trees and shrubs, over 4 ft high, dominating secondary communities are:

Acacia tortilis	Maytenus cymosus (forma DE1253)
Dichrostachys cinerea	M. cymosus (forma DE958)
Croton menyhartii (LTV)	M. senegalensis
Commiphora neglecta	Calpurnia subdecandra

Common secondary low shrubs and sub-shrubs, up to 3 ft high, are:

Blepharis natalensis	Lippia javanica
Xeromphis obovata	Aster filifolius

Annual or biennial weeds, such as *Bidens pilosa*, *Tagetes minuta* and *Zinnia multiflora*, form seasonal field layer societies.

Secondary thicket and scrub of *A. tortilis* and *Dichrostachys cinerea* is abundant on heavily disturbed areas (Photo. 50). *D. cinerea* occurs also in *Acacia karroo-A. nilotica* Thorn Veld, where it is more frequent than in the driest parts of the Valley Region. The thicket and scrub, usually between 5 and 12 ft high, is dense, with a single dominant tree or shrub stratum (Photo. 51). Browsing, grazing, trampling, and intense root competition prevent development of a shade field layer and there is severe soil erosion. Browsing of *A. tortilis* may be so severe as to maintain the plants as small, spiny cushions 2 to 4 ft high (Photos. 71, 72).

Secondary, deciduous *Croton menyhartii* Scrub, 4 to 6 ft high, occurs commonly on the valley floor and on the lower, north facing valley slopes in the Middledrift area. The communities are confined to relic *Spirostachys* Valley Woodland and *Combretum apiculatum* Tree Veld. Along the valley floor *C. menyhartii* is often co-dominant with *Euphorbia grandicornis* (see section 6.3) (Photo. 34).

Secondary thickets of *Maytenus cymosus* (forma DE1253) and *M. cymosus* (forma DE958) occur in the driest areas of the Valley Region. *M. cymosus* (forma DE958) is confined to alluvial soils. Both these 'forms' of *M. cymosus* produce spinescent shrub thickets up to 10 ft high, which are not produced by the typical form of *M. cymosus* (see Appendix 2).

M. senegalensis thickets occur in *Sclerocarya-Acacia* Tree Veld, Dry Coast *Acacia karroo-A. nilotica* Thorn Veld, in the Valley Region ecotone of the Semi-coast Bush Clump-Grassland Mosaic, and in Coast *A. karroo-A. nilotica-A. robusta* Thorn Scrub. Near the Mandini weir, *M. senegalensis* forms a thicket community several hundred acres in extent (Photo. 52). The thickets are usually 15 to 30 ft in diameter and up to 8 ft high, being often, but not always, on termitaria. Expansion of the thickets is by means of suckers, the expansion being accelerated by overgrazing.

Thicket communities, 6 to 12 ft high, of the deciduous, spinescent, resiniferous plant, *Commiphora neglecta*, occur in *Spirostachys* Valley Woodland and in the dry western parts of *Spirostachys-Acacia burkei* Woodland. These communities are of importance only between Tugela Ferry and Maqumbi.

Scrub communities, seldom more than 6 ft high, of *Calpurnia subdecandra* occur mainly on south facing slopes on soils derived from dolerite. The species is frequently an undershrub in primary vegetation, but if the taller plants are destroyed, *C. subdecandra* may assume dominance, spreading also on to old lands and overstocked veld. Due to its poisonous alkaloid content, *C. subdecandra* seldom bears evidence of browsing by goats.

A typical secondary community in the hottest and driest parts of the Valley Region is dominated by low, spinescent, sub-shrubs of *Blepharis natalensis*. Where open, upper tree and shrub layers are present, *B. natalensis* commonly forms a secondary field layer. The individual plants, between 3 and 12 ins high, may be closely spaced, but they do not bind the soil and aerial parts may often be perched on tap roots some 6 ins above the present soil level. Where *B. natalensis* communities are protected from animals, as in the Muden-

Keat's Drift area, they are invaded and suppressed by grasses.

In primary Dry Valley Scrub and Savanna, *Xeroniphis rudis* is a common shrub around the bases of trees. When the trees are destroyed, *X. rudis* persists, forming a distinctive, open, low shrub community. The plants are closely and heavily browsed, so that low, rounded cushions, 1 to 2 ft high, are formed. Between the cushions is a secondary grass layer.

While most *X. rudis* communities are relics indicative of a former scrub or savanna, in several instances evidence has been found of their spread into heavily grazed grassland. These instances occur under moist climatic conditions associated with *Acacia karroo-A. nilotica* Thorn Veld and with Coast and Semi-coast vegetation.

In the Valley Region, secondary *Aster filifolius* Scrub occurs mainly on sandy soils, derived from the middle Ecca Series, in the *Acacia robusta* Faciation of Semi-deciduous Bush (see description in Chapter 8).

6.4 Marginal and Transitional Valley Vegetation

Marginal and Transitional Valley Vegetation occurs in the moister marginal areas of the Valley Region and in the Interior Basins Region. The most extensive and important communities are those dominated by *Acacia karroo* and *A. nilotica*. These form the true Thorn Veld vegetation, distinct from the xerophytic Dry Valley Scrub and Savanna and Succulent Vegetation of the hotter and drier parts of the Valley Region (sections 6.2 and 6.3).

(A) PIONEER TREE AND SHRUB COMMUNITIES

Pioneer tree and shrub communities on rock outcrops and shallow, stony soils are dominated by:

Aloe arborescens	Combretum gueinzii
A. marlothii	Diospyros dichrophylla
A. spectabilis	Ficus spp.
Buddleia saligna	Greyia sutherlandii

Communities of *Aloe spp.*, *Combretum gueinzii*, and *Ficus spp.* are discussed in sections 6.2 and 6.3, and in Chapter 5, section 5.2.

Buddleia saligna Scrub, 8 to 15 ft high, occurs on shallow soils and on stony outcrops in Dry Coast *Acacia karroo-A. nilotica* Thorn Veld and in the Interior *A. karroo-A. nilotica* Thorn Veld (see also Chapter 5, section 5.2). On rock outcrops of dry north-facing slopes *B. saligna* Scrub is relatively stable, but on steep south-facing slopes the communities show a development to Mesophytic Kloof and Rocky Hillside Scrub and Scrub-forest (see (I) and (J)).

A deciduous, low scrub of *Diospyros dichrophylla*, up to 4 ft high, occurs on sandy, shallow, Table Mountain Series soils east of Oqaqeni. The communities are associated mainly with Dry Coast *Acacia karroo-A. nilotica* Thorn Veld and *Spirostachys-A. burkei* Woodland, but occur also at the lower altitudes of the Semi-coast Bush Clump-Grassland Mosaic. They are found also on eroded soils of the Table Mountain Series.

Small, deciduous scrub communities of *Greyia sutherlandii*, 5 to 10 ft high, occur on rocky, steep, sheltered, south facing slopes and kloofs in the Interior Valley Sub-region and Interior Basins Region. The communities become frequent in the moister parts of the Interior Basins Region where they grade into seral Uplands Forest communities (Chapter 8). *G. sutherlandii* Scrub of the Interior Valley Sub-region and Interior Basins Region represents a seral stage to Mesophytic Kloof and Rocky Hillside Scrub and Scrub-forest (see (J)).

(B) DRY COAST ACACIA-KARROO-A. NILOTICA THORN VELD

Distribution and general ecology: Covering approximately 280 square miles, Dry Coast *Acacia karroo-A. nilotica* Thorn Veld extends as a marginal vegetation to the Lower Valley Sub-region (Map 1, Photo. 53). North of the Tugela, the Dry Coast Thorn Veld is comparatively wide, following the moist zone on the south facing Valley Region slopes. The Thorn Veld zone is narrower south of the Tugela, because of the sharp fall in rainfall in the rainshadow of the crest of the Coast Hinterland Region.

Mean annual rainfall is probably between 800 and 1,000 mm. Frosts are absent or light, except in the western areas where moderately severe frosts may occur (Chapter 2). Soils are shallow and stony on the steep slopes. Sandy soils are derived from the Table Mountain Series, but on the Dwyka Series, on dolerite and on some of the Archaean Basement Complex formations, the soils may be compact and clayey. West of Mapumulo and Mbongolwane, Dry Coast *A. karroo-A. nilotica* Thorn Veld is on deeply weathered, loe[illegible] soils of the Archaean Granite.

Physiognomy and structure: Dry Co[illegible] *A. nilotica* Thorn Veld occurs as [illegible] savanna community. Scrub forms are [illegible] than in the Interior *Acacia karroo-A. nilotica* Veld, since, under the moister and warmer coastal climate, there are stronger successional tendencies towards

closed scrub. An upper, tall tree stratum over 20 ft high is sparse or absent and a deciduous, spinescent *Acacia karroo-A. nilotica* short tree stratum, 8 to 18 ft high is dominant. A shrub and small tree stratum, from 4 to 8 ft high, is often well developed, forming a nearly closed layer in scrub. In between the trees and shrubs there is a grass field layer up to 3 ft high. Under trees and shrubs, a shade field layer may be sparse or well developed. Parasites on trees and shrubs are occasional. Climbers are common in scrub.

Composition: Abbreviations used in the following lists are:

M = Mesophytic species, representing local extensions of Coast *Acacia karroo-A. nilotica-A. robusta* Thorn Scrub, mainly along streambanks, in bush clumps or in local mesic situations.

C = Species found mainly in the Coast Faciation (see Floristic Variants).

L = Lower altitude, xerophytic species.

Species found occasionally in the sparse tall tree stratum over 20 ft high are:

Acacia robusta (C)	Heeria paniculosa
A. sieberiana	Olea africana (L)
Albizia adianthifolia (M)	Rauvolfia caffra (M)
Apodytes dimidiata	Phyllogeiton zeyheri
Chaetacme aristata	Rhus legatii (M)
Commiphora Caryaefolia (M)	Schotia brachypetala
Ekebergia capensis (M)	Sclerocarya birrea
Ficus capensis (M)	Sideroxylon inerme
F. petersii	Turraea floribunda
Harpephyllum caffrum (M)	Trema orientalis
	Trichilia emetica (M)

Frequent to abundant species of the dominant, *Acacia karroo-A. nilotica* short tree layer, often dense, and from 8 to 18 ft high, are:

Acacia karroo	Canthium inerme
A. nilotica	Dichrostachys cinerea
A. gerrardii	Erythrina lysistemon
A. caffra	Rhus pentheri
Heteropyxis natalensis	Hippobromus pauciflorus
Clerodendrum glabrum	Tarchonanthus minor
Rhus rehmanniana	

Occasional to frequent or locally dominant species of the short tree layer are:

Allophylus melanocarpus (M)	Manilkara concolor (C)
Buddleia saligna	Ptaeroxylon obliquum
Clausena anisata (M)	Rhus lucida
Combretum gucinzii	R. pyroides
Cussonia kraussii (M)	Strychnos innocua (L)
Dombeya cymosa (L)	S. spinosa (L)
D. rotundifolia	Schrebera alata
Erythrina latissima	Scolopia zeyheri
Euclea crispa	Tarchonanthus trilobus
Euphorbia tirucalli (L)	Vepris undulata
Fagara capensis	Vitex rehmannii
Heteromorpha trifoliata (M)	Xylotheca kraussiana (C)

Frequent to abundant species of the shrub and small tree stratum, from 4 to 8 ft high, are:

Maytenus cymosus (typical form)	Maytenus senegalensis
M. cymosus (forma DE1253) (L)	Calpurnia subdecandra (M)
Grewia occidentalis	Putterlickia verrucosa
Ehretia rigida	Leonotis leonurus
	Vangueria infausta

Occasional to frequent species are:

Acokanthera oppositifolia	Maytenus undatus
Aloe marlothii	Maesa lanceolata (M)
A. spectabilis	Ochna natalitia
Brachylaena elliptica	Pavetta lanceolata
Caesalpinia decapetala (introduced)	Phoenix reclinata (MC)
Canthium locuples (C)	Rhus dentata
Clutia sp.	R. simii
Diospyros scabrida (C)	Tarenna barbetonensis (C)
D. glandulifera	Tricalysia lanceolata (C)
D. lycioides	Urera tenax (M)
Erythrococca natalensis	Xeromphis obovata (C)
Eugenia sp. (=DE1863)	

The grass field layer of Dry Coast Thorn Veld is dominated by the secondary species, *Aristida junciformis* —a feature which readily distinguishes Dry Coast *A. karroo-A. nilotica* Thorn Veld from the Interior *A. karroo-A. nilotica* Thorn Veld. According to an old Zulu resident on the north bank of the Tugela opposite Oqaqeni, prior to some 40 to 50 years ago the grass field layer in that area was predominantly *Themeda triandra.* This accords well with the known recent invasion by Secondary *A. junciformis* Grassland (see Chapter 7).

Climax grasses of the field layer are:

Themeda triandra	Bothriochloa insculpta
Tristachya hispida	Setaria woodii
Heteropogon contortus	

and in mesic situations, *Cymbopogon validus.*

Grasses of grazed areas and on shallow soils are:

Chloris gayana	Eragrostis superba (L)
Digitaria pentzii (L)	E. racemosa
D. macroglossa	Perotis patens
Eragrostis capensis	Sporobolus fimbriatus
E. chloromelas	Tricholaena monachne
E. curvula	Trichoneura grandiglumis

Most of these species may appear also in the climax grass field layer. As a result of selective grazing they are rapidly replaced by *Aristida junciformis*, except at drier, lower altitudes (see Chapter 7).

On stony soils the principal species are:

Aristida barbicollis	Rhynchelytrum setifolium
A. junciformis	Tragus berteronianus
Rhynchelytrum repens	

On heavily grazed, trampled and manured areas, typical species are:

Eragrostis plana	Cynodon dactylon
Sporobolus pyramidalis	

In shade, the principal grass is *Panicum maximum* and occasionally *Sacciolepis curvata*.

Low shrubs, up to 4 ft high, of the field layer in open scrub are:

Xeromphis rudis	Maesa alnifolia
Lippia javanica	Pavetta gracilifolia (L)
Lantana rugosa	P. komghensis (L)
Asparagus spp.	Canthium ciliatum
Diospyros dichrophylla (L)	C. spinosum

In dense scrub, *Hibiscus calyphyllus* is frequent.

Typical sub-shrubs and herbaceous, shade tolerant field layer species are:

Abutilon galpinii	Hypoestes verticillaris
Aneilema dregeanum	Justicia flava
Barleria elegans (L)	Leucas glabrata
B. obtusa	Peristrophe natalensis
Blepharis maderaspatensis (L)	Ruellia patula
	Sanseviera thyrsiflora
Chaetacanthus setiger	Teucrium riparium
Commelina africana	Acanthaceae spp.
Crossandra greenstockii	

Climbers are common in bush clumps and in scrub. The following occur:

Tecomaria capensis	Dalbergia obovata
Acacia ataxacantha	D. armata (M)
Plumbago capensis	Entada spicata
Clematis brachiata	Dioscorea cotinifolia
Rhoicissus tridentata	Diospyros simii
Buddleia auriculata	D. villosa (C)
Scutia myrtina	Ximenia caffra
Jasminum breviflorum	Sarcostemma viminale (L)
J. multipartitum	Senecio brachypodus
J. stenolobum	Capparis transvaalensis
Microglossa mespilifolia	Uvaria caffra

Occasional parasites on trees and shrubs are:

Loranthus dregei	Viscum rotundifolium
L. zeyheri	V. viscosum

Angiosperm epiphytes are not found.

Floristic variants: East of Oqaqeni and the Inembe River a Coast Faciation is distinguished from a westward Semi-coast Faciation by the presence or prominence of species such as:

Acacia robusta	D. dichrophylla
Albizia adianthifolia	Tarenna barbetonensis
Canthium locuples	Turraea floribunda
Cussonia kraussii	Xeromphis obovata
Diospyros scabrida	Xylotheca kraussiana
D. glandulifera	

Along streambanks, extensions of Coast Thorn Scrub and Coast Lowlands Forest into the Coast Faciation are often indicated by *Phoenix reclinata* and *Strelitzia nicolai*.

In the Semi-coast Faciation there is a low relative abundance of the Coast Faciation species, with greater abundance of species such as:

Acacia caffra	Maesa lanceolata
Dombeya rotundifolia	M. alnifolia
Rhus rehmanniana	

Mainly in the Semi-coast Faciation *A. karroo* forms a marginal consociation at the moister upper altitudes, whereas at the drier lower altitudes *A. nilotica* forms an extensive consociation. The latter is mainly an open savanna, closely resembling some of the savanna of the Interior *A. karroo-A. nilotica* Thorn Veld.

Discussion: Dry Coast *A. karroo-A. nilotica* Thorn Veld is distinguished from the Interior *A. karroo-A. nilotica* Thorn Veld (see (C)) by its scrub and bush clump character, by its floristic richness and by the abundance of coast species. Coast forest precursors and forest initials are occasional (Chapter 5). The differences between Dry Coast and Interior Thorn Veld are due to climate, Dry Coast Thorn Veld experiencing a higher mean annual rainfall, slightly better distributed throughout the year, light frosts and only occasional moderately severe frosts (Chapter 2).

Dry Coast *A. karroo-A. nilotica* Thorn Veld differs from Coast *A. karroo-A. nilotica-A. robusta* Thorn Scrub (Chapter 5) by its lower stature and more deciduous character; by the absence or sparse occurrence of *A. robusta*, a major dominant of Coast *A. karroo-A. nilotica-A. robusta* Thorn Scrub; by the low relative abundance of forest initial species and high relative abundance of xerophytic species; and successionally by the seral nature of Coast *A. karroo-A. nilotica-A. robusta* Thorn Scrub to Coast Lowlands Forest. The differences between the Coast Thorn Scrub and Dry Coast Thorn Veld are due to the drier climate of the latter community (Chapter 2).

Dry Coast *A. karroo-A. nilotica* Thorn Veld frequently invades the Semi-coast Bush Clump-Grassland Mosaic and Semi-coast Secondary *Aristida junciformis* Grassland (Photo. 17). The thorn scrub encroachment into the Coast Hinterland Region is far less extensive, however, than the invasion by the Interior *A. karroo-A. nilotica* Thorn Veld into the Interior Basins Region (see (C)). This can probably be ascribed to the grass-scrub competition and fiercer fires in the dense Semi-coast Secondary *Aristida junciformis* Grasslands which because of its unpalatable nature is seldom overgrazed.

(C) INTERIOR ACACIA KARROO-A. NILOTICA THORN VELD

Distribution and general ecology: The Interior *A. nilotica* Thorn Veld is the most important member of the type Thorn Veld communities. It covers approximately [illegible] miles or 15% of the Tugela Basin [illegible] belt of greatly varying width [illegible] around the

Interior Valley Sub-region. In the Interior Basins Region, isolated *A. karroo-A. nilotica* communities occur frequently in xeric situations.

Extensive secondary invasive *A. karroo-A. nilotica* Thorn Veld occurs in the Interior Basins Region (Photos. 54–60). It is estimated that at least 60% of the Interior Thorn Veld, shown on Map 1, has invaded in this century.

The Thorn Veld occurs mainly between 2,500 and 4,000 ft altitude, but may also be found at altitudes of 2,000 ft and 5,000 ft. Locally, *A. karroo-A. nilotica* Thorn Veld is found at high altitudes on steep north facing slopes, on shallow stony soils and where disturbance is prevalent.

The mean annual rainfall is from 601 to 800 mm. Severe frosts occur during winter on even topography, but on koppies in the western Interior Basins Region frosts are less severe and less frequent than on the flat grassland areas (Chapter 2). Soils are mainly those of the warmest, driest, least weathered and largely unleached areas of the Interior Basins Region (Chapter 3). They range from vertisols and solodised solonetzic soils, to forms transitional to fersiallitic soils. On the steep sides of the Valley Region and on the koppies of the Interior Basins Region, soils are commonly shallow, stony and skeletal. Eroded soils are frequent.

Physiognomy and structure: An upper, tall tree stratum, over 20 ft high, is very sparse. There are considerable variations in height and in the spacing of the dominant short tree stratum. In the initial stages of *Acacia* invasion of grassland, open communities of scattered, low trees from 5 to 10 ft high, are found. As the communities become older they develop either into a dense, short scrub, with frequent thickets where disturbance is marked, or where disturbance is absent into an open tree veld from 10 to 20 ft high. Subsequent disturbance may result in the development of scrub from open tree veld. Bush clumps with climbers and mesophytic species are common on mesoclines and at the more mesic, transitional upper altitudes, but bush clumps occur also in the more xerophytic forms of Interior Thorn Veld. For example, mesophytic bush clumps contain species such as *Rhus rehmanniana*, *Allophylus melanocarpus* and *Heteromorpha trifoliata*, whereas in the xerophytic bush clumps typical species are *Maytenus cymosus* (form DE1253), *Asparagus spp.*, *Ehretia rigida* and *Senecio brachypodus*.

Below the dominant short tree stratum there is a sparse to well-developed shrub and small tree layer, from 4 to 8 ft high. This stratum is prominent in scrub. A grass field layer, up to 4 ft high, is well developed, and there is a sparse to abundant, shade tolerant, mixed grass-herbaceous stratum under trees and shrubs. Climbers are occasional to frequent in bush clumps and scrub. Parasites are occasional on trees and shrubs. Angiosperm epiphytes are absent.

Composition: The most frequently occurring trees of the poorly represented tall tree stratum, over 20 ft high, are:

Cussonia spicata	Ziziphus mucronata
Acacia sieberiana	

Occasional species found mainly in the Xerophytic Faciation (see Floristic variants) are:

Schotia brachypetala	Pappea capensis
Olea africana	Euclea schimperi
Pseudocassine transvaalensis	Heeria paniculosa
	Phyllogeiton zeyheri
Premna mooiensis	Acacia robusta
Euphorbia ingens	

Frequent to abundant species of the dominant, 10 to 25 ft high, short tree stratum are (M = Mesophytic species of local mesic situations and bush clumps; LX = Lower altitude, xerophytic species):

Acacia karroo	Buddleia saligna
A. nilotica	Clerodendrum glabrum
A. caffra	Euclea crispa
A. tortilis (LX)	Rhus pentheri
	R. rehmanniana

Occasional to frequent or local abundant species are:

Acacia gerrardii	Heteromorpha trifoliata (M)
Allophylus melanocarpus (M)	Hippobromus pauciflorus
Boscia albitrunca (LX)	Pachystigma macrocalyx (M)
Canthium mundtianum (M)	Ptaeroxylon obliquum
Clausena anistata (M)	Rhus lucida (M)
Cussonia paniculosa	R. pyroides (M)
Dais cotinifolia (M)	Scolopia zeyheri
Dichrostachys cinerea	Tarchonanthus minor
Dombeya cymosa (LX)	Trimeria grandiflora (M)
D. rotundifolia	Vepris undulata
Fagara capensis (M)	Vitex rehmannii (LX)

Frequent to abundant species of the 4 to 8 ft high shrub and small tree layer are:

Maytenus cymosus (typical form)	Grewia occidentalis
	Canthium inerme (M)
M. cymosus (forma DE1253) (LX)	Diospyros lycioides
	Ehretia rigida
Vangueria infausta	

Occasional to frequent species are:

Calpurnia subdecandra (M)	Acokanthera oppositifolia
	Pavetta assimilis
Aloe marlothii	Greyia sutherlandii (M)
A. spectabilis	Rhamnus prinoides (M)
A. arborescens	Canthium gilfillanii
Brachylaena elliptica	Rhus dentata var. grandifolia (M)
Rhus dentata	

The composition and nature of the field layer depends upon the upper tree and shrub strata, on soils and on

the intensity of grazing, browsing and trampling. The primary grass field layer is a *Themeda-Hyparrhenia* Grassland (see Chapter 7), but a good deal is now subclimax as a result of grazing.

In the climax grass field layer, the principal species are (see Chapter 7 for details):

Bothriochloa insculpta	Sctaria sphacelata
Chloris gayana	S. woodii
Cymbopogon plurinodis	Themeda triandra
C. validus (M)	T. triandra var. trachyspathea (LX)
Heteropogon contortus	
Hyparrhenia hirta	Tristachya hispida

The principal subclimax grasses (see Chapter 7), occurring also in the climax stratum, are:

Digitaria pentzii	Eragrostis chloromelas
D. tricholaenoides	E. curvula
Elyonurus argenteus	E. superba (LX)

Under heavy disturbance, the principal species are:

Cynodon dactylon	Sporobolus capensis
Eragrostis plana	S. fimbriatus
	S. pyramidalis

On stony, shallow soils and on eroded areas, the principal species are (see Chapter 7):

Aristida barbicollis	Rhynchelytrum repens
Eragrostis capensis	R. setifolium
E. racemosa	

Under trees and shrubs the principal grasses are *Panicum maximum* and *Melinis minutiflora*. The latter occurs mainly in dense scrub on mesoclines.

Field layer shrubs, sub-shrubs and herbs are (LX = more prominent at drier, lower altitudes; H = Heliophytes; S = Succulents; remaining species shade tolerant):

Xeromphis rudis	Hibiscus calyphyllus
Lippia javanica	Hypoestes verticillaris
Abutilon galpinii	Justicia flava
Aloe saponaria (HS)	Kalanchoe rotundifolia (HS)
Aneilema dregeanum	
Asparagus spp.	Leonotis leonurus (M)
Barleria obtusa	Lycium spp.
Bidens pilosa	Peristrophe natalensis
Blepharis natalensis (LX)	Ruellia patula
Chaetacanthus setiger	Sanseviera thyrsiflora
Commelina africana	Tagetes minuta
Cotyledon orbiculata (HS)	Teucrium riparium
	Acanthaceae spp.

Species of Acanthaceae are more prominent at drier, lower altitudes.

The xerophytic ferns, *Pellaea calomelanos* and *Notholaena eckloniana*, occur in rocky areas, especially on dolerite koppies.

The principal climbers are:

Clematis brachiata	Chilianthus dysophyllus
Rhoicissus tridentata	Jasminum multipartitum
Acacia ataxacantha	J. spp.
A. schweinfurthii	Plumbago capensis
Asparagus falcatus	Rhynchosia carribaca
Buddleia auriculata	Scutia myrtina
Capparis transvaalensis	Ximenia caffra

Succulent climbers, mainly in the Xerophytic Faciation, are *Sarcostemma viminale* and *Senecio brachypodus*. Occasional parasites on trees and shrubs are *Loranthus dregei* and *L. zeyheri*.

Floristic variants: Five main variants of Interior *A. karroo-A. nilotica* Thorn Veld may be recognised.

(i) The *A. karroo* Consociation. The Consociation occurs in moister areas and at higher altitudes, forming a constant, outermost fringe to the Interior *A. karroo-A. nilotica* Thorn Veld. Where there is a sharp transition from *Themeda-Hyparrhenia* Grassland to Valley Vegetation, *A. karroo* may form a zone not more than 50 yards wide. The Consociation merges into *A. karroo* Riverine Woodland (section 6.2).

(ii) The *A. nilotica* Consociation. The Consociation is more xerophytic than the preceding, occurring chiefly at lower altitudes. It is typical of shallow, stony soils on north facing slopes.

(iii) The Typical *A. karroo-A. nilotica* Faciation. Both *A. karroo* and *A. nilotica* occur together over wide areas, with one or the other species slightly predominant.

(iv) The Xerophytic, Marginal Dry Valley Scrub and Savanna Faciation. The Faciation occurs in the driest areas and where there is severe erosion, chiefly at lower altitudes adjoining Dry Valley Scrub and Savanna. The Faciation occurs locally in the Interior Basins Region at Utrecht and near Spionkop in the Bergville district. It is characterised by occasional to frequent Dry Valley Scrub and Savanna elements such as *Acacia tortilis*, *Schotia brachypetala*, *Olea africana*, *Prenna mooiensis*, *Euclea schimperi* and *Acacia robusta*.

(v) The Mesophytic, Marginal Uplands Faciation. The Faciation occurs in moister areas at higher altitudes transitional to the Uplands Regions. It is essentially a mesophytic, transitional and successionally advanced form of the *A. karroo* Consociation, characterised by mesophytic bush clumps, and an abundance of mesophytic species and forest precursors. For example, *A. caffra*, *Rhus rehmanniana*, *Canthium mundtianum*, *Pachystigma macrocalyx*, *Diospyros lycioides*, *Fagara capensis*, *Clausena anisata*, *Allophylus melanocarpus* and *Heteromorpha trifoliata*.

Discussion: From both an ecological and agricultural point of view, the Interior *A. karroo-A. nilotica* Thorn Veld is of considerable importance because [illegible] spread invasion from the peripheral Valley [illegible] the Interior Basins Region (see Fact[illegible]). [illegible] such as *Acacia sieberiana*, and relic [illegible] *Themeda-Hyparrhenia* Grassland, are frequently indicators of a past *A. karroo-A. nilotica* invasion. Under

present day conditions *Acacia* invasion occurs along nearly all the outer margins of the Interior Thorn Veld. In areas such as Umhlumba Mountain near Weenen, the Helpmekaar district and on the Low Drakensberg, there is an upward *A. karroo* invasion of Uplands Forest communities. In the lower Buffalo River valley, near Elandskraal and Hlalele, there is contact of *A. karroo* with *Protea multibracteata*.

Acacia spread into *Themeda-Hyparrhenia* Grassland has been from outward movements of the marginal *A. karroo-A. nilotica* Thorn Veld of the Valley Region, and from primary and secondary *Acacia* patches on stony koppies, eroded and other secondary areas of the Interior Basins Region. These *Acacia* patches (see Map 1) are frequent in the Dry Faciation of *Themeda-Hyparrhenia* Grassland (Chapter 7) with a mean annual rainfall of less than 800 mm., becoming more abundant towards the driest areas adjoining the Valley Region. As the marginal Thorn Veld and patches of Thorn Veld join there is formed an ever increasing invasive front of *Acacia*.

Following the initial *Acacia* invasion, there is an increase in the density and height of the *Acacia spp.*, entry and increase in the number of associated species, bush clump development and scrub formation. Individual stages may change only slowly, however, and, depending on veld management, possibly over 25 years may elapse without readily discernible changes occurring.

Disturbance leading to *Acacia* invasion and scrub formation often depends on local differences in vegetation. For example, on north facing slopes the grassland is 'sweeter' and local stock concentrations may result in continuous overgrazing and scrub encroachment. *Acacia* invasion generally is evident on north facing slopes of valley sides and hills, extending on to the eroded pediment slopes.

Though *Acacia* encroachment into grassland occurs over a wide area, there is also a significant invasion of the Interior *A. karroo-A. nilotica* Thorn Veld by Dry Valley Scrub and Savanna (section 6.3). Thus, in the Greytown-Tugela Ferry area, *Euphorbia triangularis* is invading *A. karroo-A. nilotica* Thorn Veld. Far inland, at Utrecht and near Spionkop, the Interior Thorn Veld is developing into a Semi-deciduous Bush community. In all these instances, replacement of the *Acacia* community by more xerophytic communities is a consequence of soil erosion and overstocking.

(D) ACACIA SIEBERIANA TREE VELD

South of the Tugela River in the Lower Valley Subregion, *A. sieberiana* Tree Veld, from 18 to 25 ft high, is found with a grass field layer dominated by the secondary species, *Aristida junciformis*.

In the Interior Basins Region, the field layer is a *Themeda-Hyparrhenia* Grassland (Photo. 61), or is composed of secondary *Eragrostis spp.*, *Sporobolus spp.* and *Cynodon dactylon* (see Chapter 7).

Occasional *A. sieberiana* Scrub or Woodland is found on the Biggarsberg, where mesophytic associated tree and shrub species are similar to those found in *Acacia caffra* Scrub and in Mesophytic Kloof and Rocky Hillside Scrub-forest (see (F), (J)).

A. sieberiana Tree Veld occurs on deep soils or on skeletal soils in which the underlying rock is soft and easily penetrated by the tree roots. Soil types are chiefly the clay pan and other soil types of the dry areas of the Interior Basins Region (Chapter 3), but *A. sieberiana* Tree Veld occurs also on fersiallitic types. Westwards and at higher altitudes, *A. sieberiana* is injured by severe frosts. At lower altitudes, *A. sieberiana* does not occur under the Dry Valley Scrub and Savanna climate, or on the shallow soils of the steep, marginal areas of the Interior Valley Sub-region. Mature trees withstand grass fires, but young trees are injured and coppicing is frequent.

Secondary communities of *A. sieberiana* are found in dongas and on old lands. The communities are increasing, especially in the Estcourt district. Frequently, *A. sieberiana* Tree Veld on eroded areas precedes an invasion of *A. karroo-A. nilotica* Thorn Veld (see (C)).

(E) SEMI-COAST MIXED ACACIA CAFFRA SCRUB

Distribution and general ecology: Semi-coast Mixed *A. caffra* Scrub is extensively developed in the Insuzi River valley and, less commonly, along the rim and upper slopes of the Zululand side of the Tugela Valley. The communities occur on steep, south aspects at drier, lower altitudes. The climate is transitional to the misty Coast Hinterland climate (Chapter 2). Soils are shallow, stony and derived mainly from the Insuzi Series and Archaean Basement Complex (Photo. 63). On the steeply tilted strata, numerous vertical cracks and soil pockets, alternating with harder unbroken strata provide a peculiarly suitable habitat for scrub development protected from fire. Along streambanks and in deep kloofs, *A. caffra* communities adjoin Streambank and Kloof Scrub-forest (see (I) and Chapter 5).

Physiognomy and structure: Semi-coast Mixed *A. caffra* Scrub is from 12 to 20 ft high, with occasional emergent trees from 20 to 30 ft high. A shrub layer,

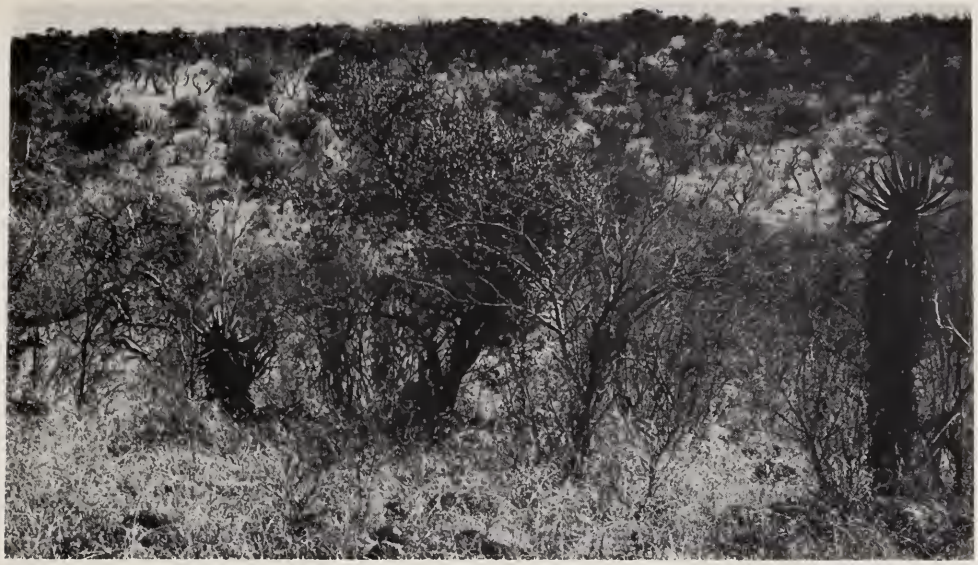


Photo. 43. Open form of Semi-deciduous Bush with good grass field layer cover of *Themeda triandra* var. *trachyspathea.* Tree and shrub species shown are *Euclea schimperi, Aloe marlothii, Acacia tortilis, Maytenus cymosus, Schotia brachypetala, Dombeya cymosa, Croton gratissimus* (rock outcrops), *Cussonia spicata, Euphorbia ingens, Brachylaena ilicifolia, Boscia albitrunca* and many others. Between Muden and Keat's Drift, lower Mooi River valley.

Photo. 44. Secondary dense, bush clump form of Semi-deciduous Bush. Trees and shrubs shown are: *Aloe marlothii, Acacia nilotica, Maytenus cymosus* (forma DE 1253), *Euphorbia pseudocactus, Asparagus sp., Xeromphis rudis* and *Opuntia sp.* (introduced). Grass stratum of *Urochloa mosambicensis.* Heavy grazing and browsing. Two miles from Weenen on Nkasine road. Interior Tugela Valley.

Photo. 45. Open, well grassed, *Vitex rehmannii* Faciation of Semi-deciduous Bush. Nkasine, Weenen area. Interior Tugela Valley.

Photo. 46. Spirostachys Valley Woodland with epiphytic orchid, *Ansellia gigantea.* Community is here a relic in a relatively lightly populated area. Near Islambo-Tugela River confluence, Ephowe district, Lower Tugela Valley.

Photo. 47. General view of prevailing secondary, mutilated remnants of *Spirostachys* Valley Woodland. Soils are severely eroded, with relic trees of the former community, such as *Spirostachys africana* and *Boscia albitrunca* (dark crowns), and the secondary species, *Acacia tortilis* and *Euphorbia pseudocactus*. Field layer sparse to absent. Note secondary absence of riverine vegetation on bare sand banks of Tugela River at winter low flow (see also Photo. 35). Half mile west of Buffalo-Tugela confluence, south bank of Tugela River.

Photo. 48. Acacia burkei Consociation of *Spirostachys-A.burkei* Woodland. Note short, continuously heavily grazed grass field layer on sandy Table Mountain Series soils. Lower Tugela Valley below Maqumbi, Mapumulo district.

Photo. 49. Relic *Boscia albitrunca*-Secondary *Acacia tortilis*-Secondary *Euphorbia pseudocactus* community typical of heavily disturbed areas of Dry Valley Scrub and Savanna. The grass field layer has been largely replaced by secondary low shrubs as a result of cultivation and continuous overgrazing. Muden, lower Mooi River valley.

Photo. 50. Extensive Secondary *Acacia tortilis* Scrub on flat, severely eroded area around Weenen (top right). Much of the area represents old cultivation. Foreground: edge of dense form of Semi-deciduous Bush. Weenen, Interior Tugela Valley.

4 to 8 ft high, is sparse to well developed. Bush clumps and climbers are common, and a grass field layer, up to 4 ft high, is poorly developed, except when the upper tree and shrub strata become open as a result of fire or clearing. A shade tolerant herbaceous field layer is sparse to well developed on steep south aspects. Parasites on trees and shrubs are occasional.

Composition: On the rugged topography there is considerable variation in composition and in the relative importance of the principal species. In addition to the typical species listed, at drier, lower altitudes, xerophytic members of the Dry Coast Thorn Veld appear, whereas at higher, more moist altitudes forest precursors and forest initials increase in abundance (see Chapter 5).

The most frequently occurring species in the sparse tall tree stratum over 20 ft high are *Cussonia spicata* and *Ziziphus mucronata*. Other tall tree species, occurring in mesic situations and on deep soils, include:

Ficus capensis	Rhus legatii
Trema orientalis	Syzygium cordatum
Trichilia emetica	Dais cotinifolia
Acacia sieberiana	Celtis africana
Commiphora harveyi	Ekebergia capensis
C. caryaefolia	Harpephyllum caffrum
Halleria lucida	

Frequent to abundant species of the dominant, deciduous short tree stratum, from 12 to 20 ft high, are:

Acacia caffra	Rhus pentheri
Dombeya rotundifolia	Heeria paniculosa
Heteropyxis natalensis	Smodingium argutum
Rhus rehmanniana	Rhus pyroides
Combretum gueinzii	Acacia karroo

Occasional to frequent species are:

Canthium mundtianum	Schrebera alata
Hippobromus pauciflorus	Scolopia zeyheri
Erythrina lysistemon	Trimeria grandifolia
Clausena anisata	Rothmannia globosa
Heteromorpha trifoliata	Dichrostachys cinerea
Allophylus melanocarpus	Vitex rehmannii
Combretum erythrophyllum	

Typical species of the shrub layer, from 4 to 8 ft high, are:

Grewia occidentalis	Diospyros lycioides
Canthium inerme	Vangueria infausta
Ehretia rigida	Maesa lanceolata
Calpurnia subdecandra	Anastrabe integerrima
Leonotis leonurus	Acalypha glabrata
Putterlickia verrucosa	Turraea obtusifolia
Maytenus cymosus (typical form)	Vernonia corymbosa
	Pavetta cooperi
M. mossambicensis	P. lanceolata
Ochna natalitia	Aloe arborescens
Rhus dentata	A. marlothii

In savanna forms of Mixed *A. caffra* Scrub, occasional to frequent primary grasses are:

Themeda triandra	Digitaria macroglossa
Hyparrhenia hirta	Eragrostis capensis
Cymbopogon validus	E. racemosa
Heteropogon contortus	Rhynchelytrum setifolium
Trachypogon spicatus	R. repens
Tristachya hispida	

Species in the right column are typical of rocky, shallow soils and *R. repens* also of secondary areas.

Under present-day conditions, primary grasses have been largely replaced by the secondary species, *Aristida junciformis* (see also Chapter 7).

Other secondary species are:

Eragrostis plana	Eragrostis curvula
Sporobolus pyramidalis	Cynodon dactylon

Under shade, occasional grasses are *Beckeropsis uniseta* and *Panicum maximum*.

The bracken fern, *Pteridium aquilinum*, is locally dominant in open scrub and tree veld.

Low shrubs of open scrub and tree veld are:

Lopholaena platyphylla	Lantana rugosa
Maesa alnifolia	Lippia javanica
Xeromphis rudis	Polygala virgata

Species in the right column also occur commonly under the relatively light canopy provided by the short tree stratum.

Herbaceous and sub-shrubby shade tolerant species are:

Acanthaceae spp.	Barleria obtusa
Hypoestes verticillaris	Teucrium riparium
Justicia flava	Commelina africana
Peristrophe natalensis	and many other species

On very steep, rocky, shallow soils of mesoclines, local species are:

Iboza riparia	Printzia pyrifolia
Nautochilus labiatus	Athrixia phylicoides
Sutera burkeana	Lotononis wyliei

Climbers in bush clumps and in scrub are:

Clematis brachiata	Scutia myrtina
Dalbergia obovata	Buddleia auriculata
D. armata	Jasminum multipartitum
Rhoicissus tridentata	Ximenia caffra
Plumbago capensis	Cissampelos torulosa
Acacia ataxacantha	Smilax kraussiana
Tecomaria capensis	Dioscorea cotinifolia
Chilianthus dysophylla	

Discussion: Semi-coast Mixed *A. caffra* Scrub is one of the communities marking the upper limit of the vegetation of the Lower Valley Sub-region. Under exceptionally favourable habitat conditions, such as along streambanks in deep kloofs, development may be to a Postclimax Forest. On south aspects, where there is protection from fire and disturbance, development is to a Mesophytic Kloof and Rocky Hillside Scrub-forest (see (1)). Mixed *A. caffra* Scrub may be derived from Mesophytic Kloof and Rocky Hillside Scrub-forest as a result of secondary influences.

As a result of fire and disturbance, Semi-coast Mixed *A. caffra* Scrub is frequently replaced by open tree veld,

and then by Secondary *Aristida junciformis* Grassland. Severe disturbance of the Secondary *A. junciformis* Grassland may result in an invasion of Dry Coast *Acacia karroo-A. nilotica* Thorn Veld (see (B)).

(F) INTERIOR ACACIA CAFFRA SCRUB AND TREE VELD

Distribution and general ecology: The Interior *A. caffra* Scrub and Tree Veld, from 3,500 to 5,000 ft altitude, represents the most mesophytic of the *Acacia spp.* communities of the interior Tugela Basin (Photo. 62). Along the Low Drakensberg, Balelesberg and Biggarsberg, *A. caffra* Scrub grades into Mountain *Podocarpus* Forest.

A. caffra communities occur commonly on dolerite soils on rocky south-facing slopes, but may also be found on other soil types and slope aspects.

Although the description that follows refers to Interior *A. caffra* Scrub and Tree Veld occurring at higher altitudes than Interior *A. karroo-A. nilotica* Thorn Veld, *A. caffra* may also be prominent on south aspects in Dry Valley Scrub and Savanna in mesophytic variations of communities such as Semi-deciduous Bush and *Combretum apiculatum* Tree Veld (see section 6.3). *A. caffra* is sometimes conspicuous also in a narrow zone between *A. karroo* and *A. nilotica* zones in the marginal Valley Region (see also Bayer, 1938).

Physiognomy and structure: The Interior *A. caffra* communities range from open tree veld to closed scrub and woodland. In scrub there are a few tall trees from 20 to 30 ft high. In woodland this stratum is closed by large crooked boled trees of *A. caffra*, 25 to 30 ft high, with a diameter at breast height of 15 to 18 ins. Except in the occasional woodland forms, the deciduous, short tree stratum, 12 to 20 ft high, is the dominant layer.

In *A. caffra* Tree Veld, a shrub and small tree layer, from 4 to 10 ft high, is sparse. The grass field layer is a mesophytic form of *Themeda-Hyparrhenia* Grassland, up to 5 ft high (Chapter 7).

In Interior *A. caffra* Scrub and Woodland, bush clumps, climbers, small tree and shrub layer species are frequent. There is a sparse, shade tolerant, herbaceous and sub-shrubby field layer up to 4 ft high. The communities are successionally closely related to Interior Mesophytic Kloof and Rocky Hillside Scrub and Scrub-forest (see (J)).

Composition: The Interior *A. caffra* Scrub and Tree Veld is composed of a mixture of Interior *A. karroo-A. nilotica* Thorn Veld species, mesophytic Uplands forest precursors and occasional forest initials.

Occasional to frequent tall trees of the discontinuous (except in woodland) tall tree stratum, from 20 to 30 ft high, are (FP = Uplands forest precursors; FI = Uplands forest initials):

Acacia caffra (dominant in woodland)	Celtis africana (FI)
Cussonia spicata	Dais cotinifolia (FI)
Ziziphus mucronata	Phyllogeiton zeyheri

Frequent to abundant species of the dominant (except in woodland) deciduous, short tree stratum, from 12 to 20 ft high, are:

Acacia caffra	Rhus rehmanniana
A. karroo	R. pentheri
Euclea crispa (FI)	

Occasional to frequent species are (LX = drier, lower altitude):

Acacia nilotica (LX)	Clausena anisata (FP)
Buddleia saligna	Scolopia zeyheri (FI)
Canthium mundtianum (FP)	Allophylus melanocarpus (FP)
Pachystigma macrocalyx (FP)	Heteromorpha trifoliata (FP)
Hippobromus pauciflorus (FP)	Dombeya cymosa (LX)
Clerodendrum glabrum (FP)	Vitex rehmannii (LX)
Fagara capensis (FP)	Dombeya rotundifolia

Typical species of the shrub and small tree stratum, from 4 to 10 ft high, are:

Maytenus cymosus (typical form)	A. spectabilis
Diospyros lycioides	Cussonia paniculosa (FP)
Grewia occidentalis (FP)	Calpurnia subdecandra (FP)
Ehretia rigida	Ochna natalitia (FP)
Vangueria infausta	Cephalanthus natalensis (FP)
Rhus dentata	Pavetta cooperi (FP)
R. dentata var. grandifolia (FP)	P. assimilis
Greyia sutherlandii	Rhamnus prinoides (FP)
Aloe arborescens	Cassinopsis ilicifolia (FP)
A. marlothii	Artemisia afra (FP)

In the heliophilous grass field layer, typical species are:

Themeda triandra	Hyparrhenia hirta
Bothriochloa insculpta	H. aucta
Setaria sphacelata	Cymbopogon validus

In shade, *Panicum maximum* occurs.

Bracken, *Pteridium aquilinum*, occurs on steep mesoclines.

Occasional low shrubs, less than 4 ft high, under a light canopy and on the margins of bush clumps, are:

Lippia javanica	Leonotis leonurus
Xeromphis rudis (LX)	Asparagus spp.
Myrsine africana (FP)	

Under dense scrub and in bush clumps an herbaceous and sub-shrubby shade tolerant field layer is usually sparse. It includes:

Commelina africana	Xerophytic Ferns
Acanthaceae spp.	

Climbers, in scrub and in bush clumps, include:

Rhoicissus tridentata	Dalbergia obovata (FP)
Clematis brachiata (FP)	Jasminum multipartitum
Scutia myrtina (FP)	Cyphostemma sp. cf.
Buddleia auriculata (FP)	C. lanigerus (= DE1033)
Chilianthus dysophyllus (FP)	Rhynchosia caribaea (FP)
	Sarcostemma viminale (LX)
Cissampelos torulosa (FP)	Dioscorea sylvatica (FP)

Occasional parasites on trees and shrubs are *Loranthus dregei* and *L. zeyheri*.

(G) DIOSPYROS LYCIOIDES SCRUB

Open *D. lycioides* Scrub, 5 to 10 ft high, is common on rocky, dolerite hills in the Interior Buffalo River Basin and along the Biggarsberg (Photo. 65). Occasional communities are found south of the Tugela River (see Appendix 2). The altitudinal range is from 3,500 to 5,500 ft on the Balelesberg.

D. lycioides Scrub is associated with *Acacia caffra* Scrub and Tree Veld, *Euclea crispa* Scrub and Tree Veld, *Rhus rehmanniana* Scrub and the *Acacia karroo* Thorn Veld Consociation (C). On koppies and escarpments *D. lycioides* forms a zone above these communities. Between 5,000 and 5,500 ft altitude, *D. lycioides* Scrub grades into *Leucosidea sericea* Scrub and Mountain Forest (Chapter 8).

The grass field layer in *D. lycioides* Scrub is a *Themeda-Hyparrhenia* Grassland, often transitional in character to *Tristachya-Digitaria* Grassland or to *Themeda-Tristachya-Digitaria* Grassland (see grasslands in Chapter 7). Where there is disturbance of the grass field layer, an increase in the density of *D. lycioides* occurs.

(H) MINOR SCRUB AND TREE VELD COMMUNITIES

Minor scrub and tree veld communities in the Marginal and Transitional Valley Vegetation are frequently dominated by trees and shrubs of:

Cussonia spicata	E. latissima
Euclea crispa	Vitex rehmannii
Rhus rehmanniana	Acacia ataxacantha
Erythrina lysistemon	Lippia javanica

Cussonia spicata is one of the most widely distributed trees in the Basin, occurring commonly in all ecological regions except in the Mountain Region. In the Interior Basins Region and marginal areas of the Valley Region, evergreen *C. spicata* communities occur frequently on rocky hillsides. They are not common in Dry Valley Scrub and Savanna, except on steep mesoclines or other mesic habitats.

The communities vary from an open tree veld, in which *C. spicata*, 15 to 25 ft high, is almost the only tree in a mesophytic, tall *Hyparrhenia spp.* and *Cymbopogon spp.* grass field layer, up to 6 ft high, to a scrub in which the more mesophytic species of Interior *A. caffra* Scrub and Interior *A. karroo-A. nilotica* Thorn Veld and forest precursor shrubs and small trees are abundant. Climbers are common in *C. spicata* Scrub. In the Valley and Interior Basins Regions, *C. spicata* communities are seral to Mesophytic Kloof and Rocky Hillside Scrub and Scrub-forest, but *C. spicata* Tree Veld may also be a secondary relic of Mesophytic Scrub and Scrub-forest.

Evergreen scrub and tree veld dominated by *Euclea crispa*, a variable species with a wide ecological range, occurs in the Interior Valley Sub-region and in the Interior Basins Region (Photo. 64). On dolerite hillsides in the Utrecht and Dundee areas, small trees of *E. crispa* dominate a scrub or tree veld from 10 to 18 ft high. In the Weenen and Tugela Ferry areas, secondary scrub, 5 to 10 ft high, occurs on severely eroded, soft Ecca shales. *E. crispa* spreads as a result of disturbance, and if burnt by fires of relatively low heat intensity coppices freely to form a scrub. On mesoclines above the Interior *Acacia karroo-A. nilotica* Thorn Veld, *E. crispa* communities represent seral stages to Interior Mesophytic Kloof and Rocky Hillside Scrub and Scrub-forest.

Deciduous scrub or tree veld of *Rhus rehmanniana*, 8 to 15 ft high, occurs in mesic situations and at higher altitudes in *Acacia karroo-A. nilotica* Thorn Veld, and in association with *A. sieberiana*, *A. caffra*, *Diospyros lycioides*, *Euclea crispa* and Mesophytic Kloof and Rocky Hillside Scrub and Scrub-forest communities. The *R. rehmanniana* communities are a stage in the development of Mesophytic Kloof and Rocky Hillside Scrub-forest (see (I), (J)).

Deciduous *Erythrina lysistemon* and *E. latissima* Tree Veld, 10 to 18 ft high, occurs on steep hillsides along the upper boundary of the Lower Valley Sub-region. Western outliers are found in the Interior Basins Region between Ladysmith and Newcastle. Both species, but especially *E. lysistemon*, are sensitive to frosts, a feature reflected in their distribution on hill slopes. The grass stratum in the Lower Valley Sub-region Tree Veld is dominated by the secondary species *Aristida junciformis*, but in the Interior Basins Region the grass layer is a *Themeda-Hyparrhenia* Grassland (see Chapter 7). On rocky hillsides, *E. latissima* occasionally forms an open scrub in which Mesophytic Rocky Hillside Scrub-forest species are the chief associates (see (J)).

Vitex rehmannii Scrub and Tree Veld, from 10 to 18 ft

high, is found at lower altitudes of marginal Valley Vegetation adjoining *Acacia karroo-A. nilotica* Thorn Veld. The communities occur principally in the lower Buffalo River valley, near Kranskop and in the Weenen area.

Dense, thorny, impenetrable thickets, up to 15 ft high, of the shrubby, scandent species, *Acacia ataxacantha*, occur in kloofs along the upper margins of the Lower Valley Sub-region and in the eastern part of the Interior Valley Sub-region. Along dry, rocky streambanks and on rocky mesoclines, the community represents a primary seral stage to semi-coast Mesophytic Kloof and Rocky Hillside Scrub-forest (see (1)), but secondary communities may be found on old cultivation and as a result of disturbance of Mesophytic Kloof and Rocky Hillside Scrub-forest.

Lippia javanica is a frequent undershrub in scrub, but when the upper tree and shrub strata are removed, the species persists and may be maintained by heavy grazing of the grass field layer. These secondary, open, low scrub communities, up to 4 ft high, are common in marginal vegetation of the Valley Region.

(1) SEMI-COAST MESOPHYTIC KLOOF AND ROCKY HILLSIDE SCRUB AND SCRUB-FOREST

This Mesophytic Scrub and Scrub-forest occurs in protected kloofs and on rocky hillsides in the marginal Lower Valley Sub-region. With increase in altitude the communities merge into Subclimax Kloof Forest and Semi-coast Forest of the Coast Hinterland Region (Chapter 5). At lower altitudes the communities merge into Hygrophilous Streambank Woodland of the Dry Valley Scrub and Savanna (see section 6.1).

When undisturbed on favourable situations, Semi-coast Mesophytic Kloof and Rocky Hillside Communities may be a scrubby, dry forest 35 ft high. Usually, however, the communities are shorter, from 15 to 30 ft high, with only occasional Semi-coast Forest initial trees over 30 ft in height. These taller, emergent species are never as high as when found in Semi-coast Forest. Semi-coast Mesophytic Kloof and Rocky Hillside Scrub, with the tall trees absent, represents a seral community to, or secondarily derived community from the Scrub-forest. Climbers and shrubs are abundant in the Scrub and Scrub-forest communities which are dense and penetrated with difficulty. An herbaceous, shade field layer is poorly developed. Epiphytic orchids and parasites on trees and shrubs are occasionally found.

In the abundant species composition, Semi-coast Forest precursors and forest initials are common (Chapter 5). Species characteristic of the marginal Lower Valley Sub-region vegetation are preponderant, however, over the forest species.

Occasional tall trees over 20 ft high are (ELTV = Eastern part of the Lower Valley Sub-region):

Albizia adianthifolia (ELTV)	Halleria lucida
Apodytes dimidiata	Harpephyllum caffrum
Cassine aethiopica	Kiggelaria africana
Celtis africana	Nuxia congesta
Chaetacme aristata (ELTV)	Olea capensis s. sp. enervis
Commiphora caryaefolia	Ptaeroxylon obliquum
C. harveyi	Rapanea melanophloeos
Cussonia spicata	Rhus legatii
Dais cotinifolia	Sideroxylon inerme
Ekebergia capensis	Trichilia emetica
Ficus capensis	Trema orientalis
F. petersii	Turraea floribunda
	Vepris undulata
	Ziziphus mucronata

The majority of these species are Semi-coast Forest precursors and forest initials (Chapter 5).

Typical species of the dense, continuous, short tree canopy, from 8 to 20 ft high, are:

Allophylus melanocarpus	Heteromorpha trifoliata
Canthium mundtianum	Heteropyxis natalensis
Cassine laurifolium	Hippobromus pauciflorus
C. sphaerophyllaea	Maytenus acuminatus
Bequaertiodendron natalensis (ELTV)	Pachystigma macrocalyx
Clausena anisata	Rhus lucida
Cussonia kraussii	R. pyroides
Diospyros natalensis (ELTV)	R. rehmanniana
D. whyteana	Rothmannia globosa
Dombeya rotundifolia	Schrebera alata
Erythrina lysistemon	Scolopia zeyheri
Fagara capensis	Smodingium argutum
Gardenia neuberia	Trimeria grandifolia
	Xylotheca kraussiana (ELTV)

Abundant shrubs and small trees, from 4 to 10 ft high, are:

Anastrabe integerrima	Grewia occidentalis
Caesalpinia decapetala (introduced)	Leonotis leonurus (margins)
Calpurnia subdecandra	Maesa lanceolata
Canthium ciliatum	Maytenus mossambicensis
C. inerme	M. undatus
Carissa bispinosa	Ochna natalitia
Cassinopsis ilicifolia	Pavetta lanceolata
Clutia galpinii	Putterlickia verrucosa
C. glabrescens	Rhamnus prinoides
Diospyros cordata	Rhus dentata
D. glandulosa	R. dentata var. grandifolia
D. lycioides (margins)	Tricalysia lanceolata (ELTV)
Ehretia rigida	Turraea obtusifolia
Erythrococca natalensis	Urera tenax
Erythroxylon emarginatum	

On the margins of the communities, from 3 to over 6 ft high, are the tall grasses:

Cymbopogon validus	Hyparrhenia glauca
Hyparrhenia aucta	H. hirta
H. cymbaria	

Typical marginal low shrubs up to 4 ft high are:

Lantana rugosa	Maesa alnifolia
Lippia javanica	Polygala virgata

Under the dense scrub and scrub-forest, a sparsely developed field layer includes shade ferns, grasses, sedges, other herbaceous and sub-shrubby plants. Representative species are:

Abutilon galpinii	Hypoestes verticillaris
Ancilema aequinoctiale	Justicia flava
A. dregeana	Nautochilus labiatus
Barleria obtusa	Panicum maximum
Commelina africana	Pellaca viridis
Cyperus zuluensis	Peristrophe natalensis
Dactyloctenium australe (ELTV)	Setaria chevalieri
Hibiscus calyphyllus	

Common to abundant climbers contributing greatly to the density of the community are:

Acacia ataxacantha	Entada spicata
A. schweinfurthii	Helinus integrifolius
Buddleia auriculata	Jasminum breviflorum
Chilianthus dysophyllus	J. multipartitum
Cissampelos torulosa	Microglossa mespilifolia
Clematis brachiata	Rhoicissus tridentata
Dalbergia armata	Rhynchosia caribaea
D. obovata	Scutia myrtina
Dioscorea cotinifolia	Smilax kraussiana
Diospyros simii	Tecomaria capensis
D. villosa	Uvaria caffra

Epiphytic orchids, such as *Mystacidium spp.*, and the parasitic *Loranthus spp.*, are occasionally found.

The Semi-coast Mesophytic Kloof and Rocky Hillside Scrub-forest, with its mixture of Semi-coast Forest and Lower Valley Sub-region species, forms the climatic climax of the marginal vegetation of the Lower Valley Sub-region. Fire and other disturbance, particularly in the western areas has caused the degradation of Semi-coast Mesophytic Kloof and Rocky Hillside Scrub-forest to more xerophytic Semi-coast Mixed *Acacia caffra* Scrub and Tree Veld (see (E)), to Secondary *Aristida junciformis* Grassland (Chapter 7) and to Dry Coast *Acacia karroo-A. nilotica* Thorn Veld (see (B)).

(J) INTERIOR MESOPHYTIC KLOOF AND ROCKY HILLSIDE SCRUB AND SCRUB-FOREST

As in the equivalent Semi-coast community (see previous), the Interior Mesophytic Kloof and Rocky Hillside Scrub and Scrub-forest is typical of kloofs and rocky hillsides relatively protected against fire and disturbance. The communities occur in marginal vegetation of the Interior Valley Sub-region and in the Interior Basins Region. At between 4,000 ft and 5,500 ft altitude the communities grade into Uplands Forest (Chapter 8). At lower altitudes in the Interior Valley Sub-region the communities merge into Hygrophilous Streambank Woodland (see section 6.2).

The communities vary from a relatively open or a dense, scarcely penetrable scrub, from 10 to 20 ft high, to a taller scrub-forest, 20 to 30 ft high, with occasional emergent species. Scrub forms are found either as priseral stages to or as secondarily derived forms from the taller scrub-forest. Climbers are numerous, contributing greatly to the density of the vegetation.

The Interior Mesophytic Kloof and Rocky Hillside Scrub and Scrub-forest is composed chiefly of a mixture of mesophytic elements of the dry Valley Vegetation, and of Uplands forest precursors and forest initials (see Chapter 8). Priseral species, such as *Aloe arborescens*, may persist in scrub, but eventually these are shaded out in the development of taller scrub-forest.

Cussonia spicata and *Ziziphus mucronata* are frequent to abundant tall trees, from 20 to 30 ft high, emergent or occasionally forming an upper canopy. Occasional to frequent species, usually emergent and including a number of Uplands forest initials, are (UM = Moister, upper altitudes; LX = Drier, lower altitudes; EIV = Eastern part of Interior Valley Sub-region):

Acacia sieberiana	Kiggelaria africana (UM)
Apodytes dimidiata	Linociera foveolata (UM)
Calodendrum capense	Olea africana (LX)
Cassine aethiopica	O. capensis subsp. enervis
Catha edulis (very local)	Phyllogeiton zeyheri (LX)
Celtis africana	Pittosporum viridiflorum (UM)
Commiphora harveyi	Ptaeroxylon obliquum
C. caryaefolia	Rapanea melanophloeos (UM)
Dais cotinifolia	Rhus legatii
Ekebergia capensis	Schotia brachypetala (LX)
Ficus capensis	Scolopia mundii (UM)
F. petersii	Trema orientalis (LX)
Halleria lucida (UM)	Vepris undulata
Harpephyllum caffrum	

Occasional tall trees of *Acacia caffra* and *A. karroo* also appear as emergent or upper canopy species.

In the heterogeneous short tree stratum, 10 to 20 ft high, forming the main canopy in scrub, the principal species are:

Acacia caffra	Euclea crispa
A. karroo	Fagara capensis
Acalypha glabrata	Ficus ingens (EIV)
Allophylus melanocarpus	F. sonderi
Buddleia saligna	Heteromorpha trifoliata
B. salviifolia (UM)	Hippobromus pauciflorus
Canthium inerme	Leucosidea sericea (UM)
C. mundtianum	Pachystigma macrocalyx
Clausena anisata	Rhus lucida
Clerodendrum glabrum	R. pentheri
Combretum erythrophyllum	R. pyroides
	R. rehmanniana
Cussonia paniculata	Scolopia zeyheri
Diospyros whyteana	Tarchonanthus minor
Dombeya cymosa (LX)	Trimeria grandifolia

D. rotundifolia (LX)
Erythrina lysistemon
Vitex rehmannii (LX)

Typical shrubs and small trees from 4 to 10 ft high are:

Artemisia afra (UM, Marginal)
Calpurnia subdecandra
Canthium ciliatum
Carissa bispinosa
Cephalanthus natalensis (marginal)
Diospyros lycioides
Ehretia rigida
Grewia occidentalis
Maytenus cymosus (typical form)
M. cymosus (forma DE1253) (LX)
M. cymosus (forma DE 958) (LX)
M. mossambicensis
Ochna natalitia
Pavetta assimilis
P. cooperi (marginal)
Putterlickia verrucosa
Rhamnus prinoides
Rhus dentata

On the margins of the Interior Mesophytic Kloof and Rocky Hillside Scrub and Scrub-forest, are tall grasses, 4 to 6 ft high, of (see also Chapter 7):

Bothriochloa insculpta
Cymbopogon validus
Hyparrhenia aucta
H. hirta

Grasses found occasionally under shade are:

Beckeropsis uniseta
Melinis minutiflora
Panicum maximum
Setaria chevalieri

Occasional to frequent marginal or shade shrubs, 3 to 6 ft high, are:

Abutilon galpinii
Dombeya pulchra
Hibiscus calyphyllus
Leonotis leonurus (marginal)
Lippia javanica
Myrsine africana
Xeromphis rudis (LX)

In dense scrub and scrub-forest, the herbaceous and sub-shrubby field layer is usually sparse, but where the upper strata are more open, species found occasionally to commonly are:

Acanthaceae spp.
Aneilema dregeanum
Asparagus spp.
Barleria obtusa
Commelina africana
Hypoestes verticillaris
Justicia flava
Nautochilus labiatus
Peristrophe natalensis
Teucrium riparium

Occasional xerophytic ferns found under light shade are:

Mohria caffrorum
Notholaena eckloniana
Pellaea calomelanos

Pteridium aquilinum occurs on scrub and scrub-forest margins on steep mesoclines.

Frequent to abundant climbers are:

Acacia ataxacantha (EITV)
A. schweinfurthii
Buddleia auriculata
Capparis transvaalensis (LX)
Cassinopsis ilicifolia
Chilianthus dysophylla
Cissampelos torulosa
Cyphostemma lanigerum
Clematis brachiata
Dalbergia obovata
Dioscorea sylvatica (UM)
Jasminum breviflorum
J. multipartitum
Melothria cordata
Plumbago capensis (LX)
Rhoicissus tridentata
Rhynchosia caribaea
Scutia myrtina
Senecio macroglossus

As in its semi-coast counterpart (see (I)), the Interior Mesophytic Kloof and Rocky Hillside Scrub and Scrub-forest represents a transitional scrub-forest climatic climax between Dry Valley Scrub and Savanna of the Interior Valley Sub-region and moist Uplands Forest. Fire and secondary factors limit the development of Mesophytic Scrub and Scrub-forest, deflecting the prisere to grassland, or causing the replacement of Mesophytic Kloof and Rocky Hillside Scrub and Scrub-forest by grassland.

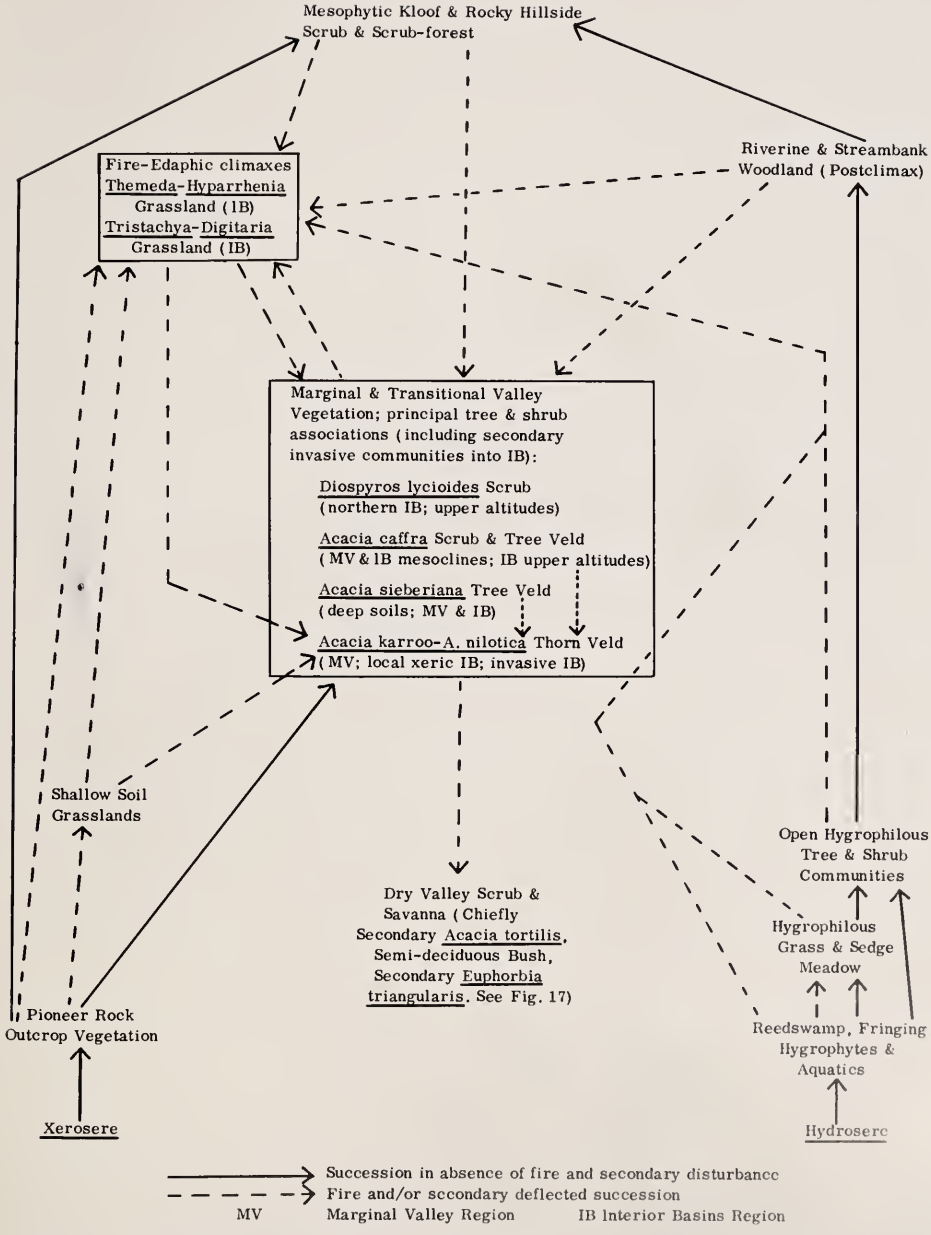

Mesophytic Kloof & Rocky Hillside Scrub & Scrub-forest
Riverine & Streambank Woodland (Postclimax)
Fire-Edaphic climaxes
Themeda-Hyparrhenia Grassland (1B)
Tristachya-Digitaria Grassland (IB)
Marginal & Transitional Valley Vegetation; principal tree & shrub associations (including secondary invasive communities into IB):
Diospyros lycioides Scrub (northern IB; upper altitudes)
Acacia caffra Scrub & Tree Veld (MV & 1B mesoclines; IB upper altitudes)
Acacia sieberiana Tree Veld (deep soils; MV & IB)
Acacia karroo-A. nilotica Thorn Veld (MV; local xeric IB; invasive IB)
Shallow Soil Grasslands
Open Hygrophilous Tree & Shrub Communities
Dry Valley Scrub & Savanna (Chiefly Secondary Acacia tortilis, Semi-deciduous Bush, Secondary Euphorbia triangularis. See Fig. 17)
Hygrophilous Grass & Sedge Meadow
Pioneer Rock Outcrop Vegetation
Reedswamp, Fringing Hygrophytes & Aquatics
Xerosere
Hydrosere
Succession in absence of fire and secondary disturbance
Fire and/or secondary deflected succession
MV Marginal Valley Region
IB Interior Basins Region

Fig. 18 Generalised Community Interrelations of Marginal Valley and Interior Basins Vegetation

CHAPTER 7

GRASSLAND VEGETATION

Grassland is the most widespread vegetation in the Tugela Basin. Above 6,500 ft, in the Mountain Region, are the temperate and transitional Mountain Grasslands discussed in Chapter 9. Below 6,500 ft, the Subtropical Grasslands discussed in this chapter comprise two main types:

(i) Dry, Transitional and Savanna Type Grasslands of the Interior Basins Region at altitudes between 3,000 ft and 5,000 ft;

(ii) Moist or 'Sour' Grasslands, with scattered forest patches, from 2,000 ft in the Coast Hinterland Region to 6,500 ft in the Uplands Regions.

The Subtropical Grasslands cover 7,700 square miles, or 69% of the Tugela catchment system (Map 1), including patches of forest and scrub. They occur mainly on flat and undulating topography, on broken topography mosaics of grassland and tree or shrub communities being common. Secondary scrub has recently become dominant over considerable areas in the Interior Basins Region (see Chapter 6), but only in relatively small patches of the Uplands Regions (see Chapter 8).

7.1 Aquatic and Hygrophilous Vegetation

The vegetation discussed in this chapter includes the herbaceous vegetation of the hydrosere in the Interior Basins and Uplands Regions. It consists of aquatics, reedswamp and fringing hygrophytes, sedge meadow and hygrophilous grass meadow. Hygrophilous tree and shrub communities found in the Interior Basins and Uplands Regions are discussed in Chapters 6 and 8 respectively.

Aquatic and hygrophilous vegetation occurs in vleis, pans, rivers and streams. Pans, consisting of water-filled depressions with no exit, are limited in number and extent, except on the Buffalo River Flats. During winter, water levels fall considerably and small vleis, streams and pans may dry up completely.

With decreasing soil moisture around vleis there is a zonation of vegetation from aquatics to reedswamp and fringing hygrophytes, to sedge meadow and to hygrophilous grass meadow. The aquatic and reedswamp zones are usually absent, or represented only by a narrow zone of fringing hygrophytes in small sponge areas that do not hold water permanently.

Because of substrate variations and flood disturbance, the zonation of vegetation is more complex along rivers and streams than around vleis. As indicated for the Valley Region (Chapter 6, section 6.1), three main zones of riverbank vegetation can be distinguished:

(i) A lower fringing zone, submerged during high flow periods.

(ii) A middle zone, fringing during high flows and submerged during floods.

(iii) An upper zone, fringing only during high floods.

Within these three zones, substrata are of two main types: (i) Gravel, stone, or boulder; (ii) Sand, mud, or fine alluvium.

Because of cold air drainage, the vegetation of vleis and rivers is subject to lower winter minimum temperatures than that on the surrounding higher ground. Severe frosts may thus limit the development of Streambank Forest in the Highlands Region, and of Hygrophilous Woodland in the Interior Basins Region. Fire prevents the development of hygrophilous tree and shrub communities in most of the Interior Basins and Uplands Regions, and it is only on rocky streambanks, to some degree protected from fires, that tree and shrub communities are found (see Chapters 6 and 8).

(a) AQUATIC COMMUNITIES

Submerged aquatic plants form initial stages of the hydrosere. Of these plants, only the highly specialised *Sphaerothylax algiformis* is found in fast flowing water. The rest occur only in the quiet waters of vleis and pans, or in still river backwaters during the low flow periods of autumn and winter.

Algae include species of *Spirogyra*, *Cladophora*,

Photo. 51. Interior of a dense stand of *Acacia tortilis* on old crop site. Note that despite closed canopy there is a well-developed field layer of shade tolerant grasses and herbs (see also Photos. 58 and 59). Soils here are over one foot deep, clayey, dark, with calcareous nodules, and grazing and browsing are light.

Photo. 52. Maytenus senegalensis Thicket Veld in Lower Tugela Valley-Coast Lowlands transition near Mandini Hydroweir. Low shrub cushions, as in right foreground, of heavily browsed *Xeromphis rudis*. Note short, open grass cover due to continuous overgrazing. Soils are poorly drained, clayey, lateritic.

Photo. 53. View west across Lower Tugela Valley from north bank opposite Oqaqeni, Mapumulo district. Dry Coast *Acacia karroo-A.nilotica* Thorn Veld in foreground down to Tugela River, with patches of cultivation and Secondary *Aristida junciformis* Grassland. Across Tugela, extensive *Euphorbia tirucalli* Succulent Scrub, and above, in distance, Dry Coast Thorn Veld again. Occasional relic large riverine trees of *Ficus sycamorus* and *Trichilia emetica* in cultivated alluvial lands along river.

Photo. 54. Interior *Acacia karroo-A.nilotica* Thorn Veld at its eastern limits in narrow section of Tugela Valley west of Mfongosi. Note that despite continuous, heavy grazing of the grass stratum there is little scrub formation by *Acacia spp.*, because of heavy browsing by goats and utilization of wood by Bantu.

Photo. 55. Acacia karroo-A.nilotica Thorn Veld between Winterton and Ladysmith. Large tree in centre is *A.karroo*, and numerous smaller trees of *A.karroo* and *A.nilotica*. Incipient bush clump around large tree. Grass stratum recently burnt.

Photo. 56. Secondary scrub form of *Acacia karroo-A.nilotica* Thorn Veld with poor, continuously overgrazed grass stratum and severe soil erosion. Note patchwork cultivation. Dark crowns of evergreen *Cussonia spicata* trees. Local secondary succulent *Euphorbia triangularis* Consocies at left, centre and right. Marginal Valley Vegetation between Greytown and Keat's Drift.

Photo. 57. Acacia karroo-A.nilotica Thorn Veld in flat-bottomed, shallow valley of Tugela River between Winterton and Ladysmith. Thorn Veld is here invading downwards from hillsides on to flat areas, especially along dongas. Note repetition on distant hills. Density of Thorn Scrub on hills is a secondary feature, and represents a local development of the Xerophytic Marginal Dry Valley Scrub and Savanna Faciation of the *A.karroo-A.nilotica* Thorn Veld.

Photo. 58. Comparatively young secondary thicket of *Acacia karroo-A.nilotica.* Note that despite density of shrubs a grass cover is still present, especially near the bases of the stems where the grass cannot be reached by grazing animals (see Photo. 59). Near Gannahoek farm, Monte Christo area, Colenso district.

Nitella and Cyanophyceae. Submerged angiosperms, forming dense communities, are *Lagarosiphon muscoides*, *L. major*, *Potamogeton octandrus* and *P. trichoides*.

Free-floating aquatic plants are usually poorly represented. They are almost entirely limited to vleis and pans, where they often intermingle with partly emergent aquatic vegetation, with reedswamp and with fringing hygrophytes. *Wolffia sp.* (Photo. 76) and *Lemna minor* may be found floating in dense masses on the surface of ponds. *Utricularia spp.* are less common.

Rooted, partly emergent aquatics in shallow waters form a zone adjoining and frequently intermingling with reedswamp and fringing hygrophytes (Photos. 75, 76). Typical are the floating-leaved aquatic *Potamogeton nodosus*, and the partly emergent species, *Aponogeton spathaceum*, *A. natalense*, *Limosella maior* and *L. longiflora*. Semi-aquatics, such as *Polygonum spp.* and *Scirpus fluitans*, have wide ranges of moisture tolerance, frequently appearing in the stage of partly emergent aquatic plants as well as in the semi-aquatic reedswamp and fringing hygrophyte stage.

(B) REEDSWAMP AND FRINGING HYGROPHILOUS COMMUNITIES

For the greater part of the year these communities are rooted in water from 6 ins to 2 ft deep. They occur in the lower fringing zone along rivers and around the aquatic zones of vleis. The plants may be burnt during the dry season, but the lower portions and roots are protected by the moist soil.

Reedswamp communities, from 3 to over 6 ft high (Photos. 75, 77), are dominated by:

Phragmites communis	Miscanthidium junceum
Cyperus fastigiatus	Typha capensis

Fringing hygrophilous communities, occurring in habitats similar to those of reedswamp, may be up to 4 ft high. They are composed of rushes, sedges, grasses and other herbs, often appearing as narrow, fringing zones along small streams and around small vleis (Photos. 74, 75, 77). Typical species that form communities are:

Pennisetum natalense	J. suboxycarpus
P. thunbergii	J. sp. (DE1051)
Cyperus marginatus	Scirpus inclinatus
Anoiganthus breviflorus	S. muricinux
Gunnera perpensa	S. paludicola
Sium thunbergii	S. fluitans
Polygonum lapathifolium	S. macer
P. pulchrum	Eleocharis dregeana
P. salacifolium	Carex sp. (DE2160)
P. strigosum	C. sp. (DE2418)
Juncus effusus	Leersia hexandra
J. exertus	Echinochloa crusgalli (introduced)
J. oxycarpus	E. crus-pavonis (introduced)
J. punctorius	Phalaris arundinacea
	Equisetum ramosissimum

The species are arranged in order from hydric to mesic.

(C) HYGROPHILOUS GRASS AND SEDGE MEADOW

Hygrophilous Grass and Sedge Meadow occurs principally in the upper zone along rivers and in the outermost zones of vleis, where it is indicative of the high water table that occasionally rises above the soil surface during summer (Photo. 74). During winter soils may become dry, and the aerial parts of the plants are killed by frost.

Along the upper Hlatikulu River, at Ntabamhlope and in other parts of the Highlands Region, Hygrophilous Grass and Sedge Meadow may have a distinctive hummock structure in which steep-sided grass or sedge covered mounds, from one foot to two and a half feet high, are separated by a network of narrow channels of shallow water (Photo. 78). On individual hummocks there is a micro-zonation of plants, with the most hygrophilous species in the moist lower parts, and more mesic plants on the drier upper parts. Ant nests are found in the hummocks, the ants apparently constructing their heaps upon raised grass and sedge tussocks and on flood debris (West, 1951). Vegetation grows on and through the ant heaps, forming a steep sided hummock, which in cross-section shows numerous plant roots and ant tunnels. Ants from the upper Hlatikulu vlei were identified by Dr. G. Arnold of Bulawayo as *Euponera* (*Trachymesopus*) *wroughtonii* Forel *var. crudelis* Forel. West (1951) collected three species of ants (not identified) in the Ntabamhlope vleis noting that mole rats and earthworms were also present and that numbers of the latter were raising the ground level in wet soil between the hummocks.

The rôle of animals in this plant succession has also been indicated by Killick (1963), who considered a mole or mole rat to be the cause of hummock formation in Alpine Sedge Meadow (see Chapter 9). Trampling by grazing animals also commonly causes hummocks in vleis (Killick, 1959; Martin, 1960), but these are usually lower and more rounded or flattened in profile than those for which ants are responsible. Intermediate hummock forms occur when cattle trample and break down the steep-sided ant hummocks.

Hygrophilous Grass and Sedge Meadow is regularly burnt with the surrounding grasslands during autumn or winter, or early spring. Burning in autumn is followed by new growth eagerly sought by stock: such

sometimes being used to provide early winter grazing. Injudicious autumn burning practices and continuous overgrazing and trampling often result in donga erosion, lowering the water table and causing the replacement of Hygrophilous Grass and Sedge Meadow by drier grassland communities. Donga erosion is particularly common in vleis associated with the Dry Faciation of *Tlemeda-Hyparrhenia* Grassland (see also Chapter 3).

Sedge Meadow, 0·5 to 2 ft high, occurs on moister soils than does Hygrophilous Grass Meadow. Sedges that form communities are:

Cyperus denudatus	Pycreus macranthus
C. sphaerospermus	P. mundtii
Scleria welwitschii	P. oakfortensis
S. woodii	Fuirena pubescens
Kyllinga aurata	F. pachyrhiza
K. melanosperma	Fimbristylis complanata
K. sp. (DE1045)	F. dichotoma
	Bulbostylis schoenoides

The species are arranged in order from hydric to mesic.

Consocies and associes of *Pycreus macranthus*, *Fimbristylis complanata* and *Fuirena pubescens* are frequent in the Interior Basins and Uplands Regions, representing the most important of the drier types of Sedge Meadow.

Species forming Hygrophilous Grass Meadow communities are:

Eriochrysis pallida	Agrostis huttoniae
Arundinella nepalensis	A. lachnantha
Paspalum distichum	Eragrostis nebulosa
P. commersonii	E. planiculmis
P. dilatatum (introduced)	Andropogon appendiculatus
P. urvillei (introduced)	A. eucomis
Hemarthria altissima	Pennisetum clandestinum (introduced)
Beckeropsis uniseta	Cynodon dactylon
Imperata cylindrica	

The species are arranged in approximate order from hydric to mesic.

Low-growing communities, less than 18 ins high, are formed by *Eriochrysis pallida*, *Paspalum distichum* and *Cynodon dactylon*. The remaining species form communities from 2 to 4 ft high when there is no heavy grazing.

Along rivers Hygrophilous Grass Meadow occurs on mud and sand banks, species such as *Arundinella nepalense*, *Hemarthria altissima*, *Beckeropsis uniseta*, *Imperata cylindrica* and *Cynodon dactylon* often dominating conspicuous zones (Photo. 74). Tufted, fine-leaved consocies and associes of *Agrostis spp.* and *Eragrostis spp.* occur frequently in conjunction with *Pycreus-Fimbristylis-Fuirena* Sedge Meadow.

Consocies of *Imperata cylindrica* and *Andropogon eucomus* are common on poorly drained, sandy soils underlain by ferruginous hardpan. Secondary communities of these two species occur on similar soils in roadside drains, in dongas and on old lands.

Dense, short grass communities of *Cynodon dactylon* and, occasionally, the introduced *Pennisetum clandestinum*, occur on riverbanks and around vleis, as well as on comparatively dry areas around habitations and stock kraals. The communities are relatively stable on moist habitats under heavy grazing and manuring (see section 7.5).

In Hygrophilous Grass and Sedge Meadow numerous associated plants may be found. Often these are particularly striking and attractive, but grazing and trampling considerably reduces their numbers. A few of the species are:

Agapanthus natalensis	Gladiolus papilio
Chironia krebsii	Kniphofia spp.
Denekia capensis	Lobelia decipiens
Disa chrysostachya	Lotononis solitudinis
Eucomis spp.	Mimulus gracilis
Eulophia zeyheri	Ranunculus multifidus
Geranium canescens	Satyrium longicauda
	Zantedeschia aethiopica

In addition there may be numerous associated grassland plants (see section 7.8, Appendix 2).

7.2 Grass Communities of Rock Outcrops and Shallow Soils

Grass communities are not typical of the earliest stages of the xerosere in the Coast, Uplands and Interior Basins Regions, but enter the succession after there is an accumulation of soil in the cracks and crevices of rocks or on shallow soils. The initial, non-grass plant communities found on rock outcrops are described in Chapters 5, 6 and 8.

Development of the xerosere is generally more rapid upon dolerite outcrops, because of their relatively rapid weathering and formation of deep soils between the rounded boulders. Dolerite outcrops thus commonly support a more mesophytic, later seral stage grassland than is found on soils overlying shale and sandstone rock strata.

Because of the protection afforded by local topography and by the rocky habitat, and the limited amount of organic material from the open, short grass cover on rock outcrops and on shallow soils, fires are less frequent and of lower intensity than in grassland on deeper soils. Numbers of herbs and occasional shrubs and trees may thus be found in Rock Outcrop and Shallow Soil Grass Communities.

Dominant grasses on rock outcrops and shallow soils are:

Rhynchelytrum repens	A. galpinii
R. setifolium	Digitaria monodactyla
Aristida barbicollis	Microchloa caffra
A. bipartita	Rendlia altera
A. curvata	Eragrostis racemosa
A. monticola	E. capensis
A. junciformis	

The species are arranged in order from xeric to mesic.

Communities of *Rhynchelytrum spp.* occur principally on rock outcrops in the Interior Basins Region, but are also frequent in the Uplands and Coast Regions (see also Secondary Grasslands, section 7.5).

Xeromorphic bunch grass communities of *Aristida barbicollis*, *A. bipartita* and *A. curvata* occur throughout the Tugela Basin, except in the Alpine Belt of the Mountain Region. *A. barbicollis* may be found on extremely xeric habitats, as for example, on eroding shales in the Valley Region. *A. junciformis*, dominant in an extensive secondary grassland in the Coast Hinterland and Midland Mist Belt Regions (see section 7.6), occurs also in the early xerosere of these regions and, occasionally, in the Highlands Region. At the higher altitudes of the Highlands Region and in Subalpine vegetation of the Mountain Region, *A. junciformis* is replaced by *A. galpinii* (see Appendix 2). On boulder beds along rivers in the upper Highlands Region, and on rock outcrops in the Subalpine Mountain vegetation, *A. monticola* is a dominant species.

Digitaria monodactyla, *Microchloa caffra* and *Rendlia altera* form communities on shallow soils in the Uplands and Interior Basins Regions. These communities are generally less than one foot high and of a fine-leaved, densely tufted, short bunch grass type.

Eragrostis racemosa and *E. capensis*, on shallow soils, form short bunch grasslands, up to 15 ins high, which are connected by all stages of transition to shallow soil variants of the major grassland associations.

7.3 Dry, Transitional and Savanna Type Grasslands

Dry, Transitional and Savanna Type Grasslands of the Interior Basins Region cover approximately 5,100 square miles, or 46% of the Tugela Basin. They occur chiefly at altitudes between 3,500 and 4,500 ft, extending occasionally to over 5,000 ft and down to 3,000 ft. The two major associations are *Themeda-Hyparrhenia* Grassland and *Tristachya-Digitaria* Grassland.

Severe frosts occur, but east of the Buffalo River the grasslands are subject to less frequent severe frosts than in the western areas (Chapter 2).

The mean annual rainfall is between 601 mm. and 1000 mm., but mist and low intensity precipitation are less than for the Moist Grasslands of the Coast and Uplands Regions (Chapter 2). With increase in rainfall in the Interior Basins Region, relative abundance of species and the composition of the grasslands change. Dry faciations of *Themeda-Hyparrhenia* Grassland and *Tristachya-Digitaria* Grassland occur where the mean annual rainfall is less than 750 mm. to 800 mm., and moist faciations where the mean annual rainfall is above this amount. The distribution and extent of these moist and dry types of Interior Basins' grassland are shown on Map 1.

(a) THEMEDA-HYPARRHENIA GRASSLAND

Distribution and general ecology: Themeda-Hyparrhenia Grassland (Tall Grassveld, Pentz, 1940, 1945; Southern Tall Grassveld, Acocks, 1953) is the most extensive plant association of the Tugela Basin, covering approximately 3,600 square miles, or 32% of the catchment area (Map 1). The Dry and Moist Faciations cover 1,900 and 1,700 square miles, or 17% and 15% respectively, of the Basin (Photos. 73, 79, 80). Its distribution is chiefly south of the Biggarsberg, extending eastwards to Qudeni and almost to Kranskop. North of the Biggarsberg, *Themeda-Hyparrhenia* Grassland is largely peripheral to *Tristachya-Digitaria* Grassland on flat, lower-lying areas with sandy soils.

Themeda-Hyparrhenia Grassland occurs either as a broad or as a narrow belt between Valley Vegetation and moist vegetation of the Highlands Region. West of Estcourt and Ladysmith, the belt of grassland reaches a width of over 30 miles. Between Estcourt and Kranskop, however, the Grassland forms a narrow belt, sometimes less than a few hundred yards wide. The narrowness of the belt here corresponds with the sharp change in climate between the Valley and Highlands Regions, but the *Themeda-Hyparrhenia* belt has sometimes been narrowed, or even become completely obscured, by *Acacia karroo-A. nilotica* scrub encroachment (see Chapter 6).

Physiognomy and structure: General features which distinguish *Themeda-Hyparrhenia* Grassland from other grasslands are the co-dominance of *Hyparrhenia hirta* and the abundance of tall, bunch grass communities of *H. aucta* and *H. tamba*. Tall trees of *Acacia sieberiana* up to 25 ft high, are scattered throughout the Grassland (Chapter 6). *Acacia karroo-A. nilotica* Thorn Veld occurs mainly in the Dry Faciation of *Themeda-Hyparrhenia* Grassland on xeroclines on stony, shallow soils and on secondary areas. *A. caffra* Scrub and Tree

Veld occurs in both the Moist and Dry Faciations on dolerite hills (Chapter 6).

Structurally, *Themeda-Hyparrhenia* Grassland consists of three main layers:

(i) A discontinuous to continuous upper stratum of later summer and autumnal aspect bunch grasses, with robust culms and cauline leaves, from 2·5 to 5 ft high. *Hyparrhenia hirta* is the dominant species.

(ii) A continuous, mid-grass stratum, from 1·5 to 3 ft high, in which most grasses occur, including the co-dominant, *Themeda triandra*.

(iii) A discontinuous lower stratum of short bunch, rhizomatous and stoloniferous grasses, in which culm height may be somewhat over 1·5 ft high, but the main leaf growth is from near ground level to 1 ft high. *Eragrostis racemosa* and *Digitaria tricholaenoides* are some of the principal species of this stratum.

The heights of the various layers vary with the frequency and time of burning, with grazing and with the seasons (section 7.6). Heights given represent those found under the most favourable conditions. As may be expected from its savanna nature (sensu Yangambi classification, Boughey, 1957) and occurrence under a drier climate, basal cover in *Themeda-Hyparrhenia* Grassland is lower than in the Moist Grasslands. At the Estcourt Pasture Research Station, percentage basal cover determinations in typical undisturbed veld (West, 1951) ranged from 20·0% to 45·5%, with *Themeda triandra*, *Tristachya hispida* and either *Hyparrhenia hirta* or *Heteropogon contortus* and *Digitaria monodactyla*, as the principal species.

Composition: Common to abundant and dominant grasses are:

Themeda triandra	Eragrostis racemosa
Tristachya hispida	E. capensis
Hyparrhenia hirta	Heteropogon contortus

Occasional to frequent, or locally dominant grasses are:

Alloteropsis semialata (M)	Eragrostis chloromelas (D)
Andropogon amplectens (M)	E. curvula
A. appendiculatus (M)	E. superba (VD)
A. filifolius (M)	Festuca scabra
Aristida barbicollis (D)	Harpechloa falx (M)
A. bipartita	Helictotrichon hirtulum
Brachiaria serrata	Microchloa caffra
Cymbopogon excavatus (M)	Monocymbium ceresiiforme (M)
C. plurinodis (D)	Panicum natalense (M)
Cynodon dactylon (D)	Setaria flabellata
Digitaria monodactyla	S. nigrirostris
D. tricholaenoides	S. woodii (D)
Elyonurus argenteus	Sporobolus stapfianus
	Trachypogon spicatus (M)

M = species mainly of Moist Faciation (see floristic and ecological variants)

D = species mainly of Dry Faciation (see floristic and ecological variants)

VD = species of driest, marginal Valley areas (see floristic and ecological variants)

Species which appear occasionally in relatively undisturbed veld, or as persistent indicators of past disturbance, are *Eragrostis plana*, *Sporobolus capensis* and *S. pyramidalis* (see also discussion).

Trachypogon spicatus is sensitive to overgrazing, and under these conditions *Eragrostis spp.*, *Sporobolus spp.*, *Aristida spp.* and *Cynodon dactylon* increase in abundance. An abundance of *Elyonurus argenteus* appears to be associated mainly with sheep grazing.

Forbs are less prominent than in Moist Grasslands (see section 7.7).

Floristic and ecological variants: Considerable variations in the relative importance of the various grasses depend on climate, soils, grazing and burning. *Themeda triandra* includes several ecotypes. Between Weenen and Estcourt, for example, there is a morphological gradation between tall, probably tetraploid, forms at Weenen (Pienaar in Meredith *et al.*, 1955), and short, probably diploid, forms at Estcourt.

Two climatically determined faciations are recognised, these being the Dry and the Moist Transitional types of *Themeda-Hyparrhenia* Grassland shown on Map 1.

(i) *The Dry or Typical* Themeda-Hyparrhenia *Faciation.* Mean annual rainfall is from 601 mm. to 750 mm. or 800 mm. Soils are predominantly highly erodible, largely unleached claypan types often showing the morphology of solodised solonetzic soils, and claypan soils transitional to fersiallitic soils (see Chapter 3). The Faciation is often a very open *Acacia sieberiana* Savanna. Co-dominance of *Hyparrhenia hirta* is well marked in the Faciation. More xerophytic grasses, such as *Eragrostis superba* and *Cymbopogon plurinodis*, increase in abundance with decrease in mean annual rainfall below 700 mm. Scrub encroachment by *Acacia spp.* appears throughout the Faciation, and below 700 mm. mean annual rainfall, it has been invaded over large areas by the Interior *Acacia karroo-A. nilotica* Thorn Veld. At least 60% of the area shown on Map 1 as Interior Thorn Veld appears to have been *Themeda-Hyparrhenia* Grassland.

(ii) *The Moist Transitional* Themeda-Hyparrhenia *Grassland Faciation.* Mean annual rainfall is from 750 mm. or 800 mm. to 900 mm., or up to 1,000 mm. in the Geluksberg area and the deep valleys that cut back

into the South-western Highlands. The soils are predominantly fersiallitic, partly leached types (see Chapter 3). The Faciation is distinguished physiognomically by a lower abundance and patchy distribution of *Hyparrhenia hirta*. Moist Uplands grasses are prominent: for example, *Monocymbium ceresiiforme*, *Harpechloa falx*, *Trachypogon spicatus* and *Andropogon filifolius*. There are few patches of Interior *Acacia karroo-A. nilotica* Thorn Veld and thorn encroachment is infrequent.

Within the faciations of *Themeda-Hyparrhenia* Grassland, local edaphic and topographic variants can be grouped into five main types:

(i) *Sedimentary Soil Variants*. These are regarded as the typical *Themeda-Hyparrhenia* Grassland types, developed on soils largely derived from sedimentary rock materials. The Moist Transitional Faciation occurs mainly on greybrown, fersiallitic soil types, whereas in the Dry Faciation the soils are mainly claypan and transitional types (see Chapter 3).

(ii) *Dolerite Soil Variants*. Dolerite soils are frequent and often extensive. The soils are often rocky, and woody plants may be frequent. Red, residual fersiallitic soils of dolerite origin have a higher nutritional status than soils derived from sedimentary rocks, and this is apparently reflected in the 'sweeter' and more palatable character of the grasses. Although *Hyparrhenia hirta* is often abundant on dolerite soils, heavy grazing may result in the production of a short, dense grassland dominated by *Themeda triandra* to the exclusion of other species. In the driest parts, on vertisols, or 'black turf' soils largely of dolerite origin, *Bothriochloa insculpta* is frequently a co-dominant or abundant species with *Themeda triandra*.

(iii) *Shallow Soil Variants*. These are often extensive, occurring where the soil is less than one foot deep. Variations in soil depth occur on undulating topography, deeper soils being found in the troughs and shallow soils on the crests of the undulations. Grassland variants of dry ferruginous hardpan soils on minor ridges are also included here. In Shallow Soil Variants, basal cover is lower, with shorter, more xerophytic species, such as *Eragrostis racemosa*, *Microchloa caffra* and *Aristida barbicollis*, more abundant than on deep soils. The Shallow Soil Variants may be regarded as late xerosere stages, forming the gradation from shallow soil communities of the xerosere to grassland on deeper soils.

(iv) *Transitional* Themeda-Hyparrhenia *to* Tristachya-Digitaria *Grassland Variants*. These Transitional Variants occur on rather sandy soils, usually found north of the Tugela River. The Variants are generally relatively short, tending in physiognomy and composition to *Tristachya-Digitaria* Grassland. *Hyparrhenia hirta* is inconspicuous except on disturbed areas.

(v) *Slope Aspect Variants*. Variations in grassland due to slope aspect become more significant with increase in slope angle. On moister south and south-east facing slopes, the grassland is successionally more advanced, with taller, coarser and 'sour' grasses, for example *Cymbopogon spp*. On north and north-west facing slopes the grass is shorter, with a lower basal cover and with xerophytic elements such as *Aristida spp*. Stock tend to overgraze the 'sweeter' veld on north aspects, resulting frequently in *Acacia spp*. scrub encroachment.

Discussion: In Chapter 4 it was shown that the area of the Dry Faciation of *Themeda-Hyparrhenia* Grassland has long been heavily settled, first by Bantu, who were driven out by Shaka in the early nineteenth century, and subsequently by European settlers. Barter (1852) and West (1951) noted numerous old stone kraals on the Draycott Plain, indicating that the area, at one time, carried a considerable Bantu population. The construction of the main road and rail routes, chiefly in the Dry Faciation, resulted in an over intensified use of the land in their vicinities since about 1890. The results of this disturbance are today apparent in the breakdown of soils, in extensive *Acacia karroo-A. nilotica* scrub encroachment and in a secondary grass cover in the driest areas marginal to the Valley Region.

The historical pattern of disturbance is of significance also in that it tends to confirm a secondary origin for *Hyparrhenia hirta* in *Themeda-Hyparrhenia* Grassland, accounting for *H. hirta* dominance chiefly in the Dry Typical Faciation. Glover (1937), West (1951) and Story (1952) all note the occurrence of *H. hirta* as a secondary species, and of its persistence as an indicator of past disturbance. In Moist Transitional *Themeda-Hyparrhenia* Grassland, *H. hirta* distribution is distinctly patchy, nearly always occurring where some disturbance or break in the grass cover is evident. In the Moist Faciation, there has been less secondary influence than in the Dry Faciation, 'undisturbed' grassland showing a composition close to the *Themeda-Trachypogon* Highlands Grassland. Somewhat similar small patches of 'undisturbed' grassland in the Dry Faciation may well be relics.

West (1951) has pointed out that *H. hirta* with its deep root system (Coetzee *et al.*, 1945), maturing and

flowering in late summer, is ecologically well fitted to play an important rôle in a grassland dominated by shallower rooted and early flowering grasses, such as *Themeda triandra* and *Tristachya hispida*. But secondary *H. hirta* is common also on shallow shale soils and on road cuttings, where a shallow root system only can develop.

Unless veld is well managed *H. hirta* tends to spread because of selective grazing, reducing competition from other species.

The readiness with which *H. hirta* tends to become dominant as a result of disturbance is apparent along roadsides and in an extensive *H. hirta* invasion into *Themeda-Trachypogon* Highlands Grassland in recent years.* Secondary *H. hirta* communities have been recorded at altitudes up to 8,000 ft in the Mountain Region.

H. hirta exhibits a considerable measure of stability in grassland. In *Themeda-Hyparrhenia* Grassland, it appears to have attained the status of a climax species.

(B) TRISTACHYA-DIGITARIA GRASSLAND

Distribution and general ecology: This Grassland (Sandy Sourveld, Pentz, 1940, 1945; Natal Sour Sandveld, Acocks, 1953) exists mainly in the Interior Basin of the Buffalo River, the principal outliers south of the Biggarsberg occurring in the Wasbank and Sundays River valleys. The topography is the most even in the Tugela Basin. The Association covers approximately 1,500 square miles, or 13% of the Tugela Basin, at altitudes between 3,500 and 4,500 ft. The Grassland is composed of a Transitional Faciation covering about 250 square miles, and a Dry Faciation covering 1,250 square miles (see Map 1, Photos. 81–86).

The climate of *Tristachya-Digitaria* Grassland is similar to that of *Themeda-Hyparrhenia* Grassland, causing analagous faciations to be found. Soils, which are largely grey-brown fersiallitic and ferruginous hardpan types, are associated with the Middle Ecca geological formation. They are all nutritionally poor, sandy types, ranging from deep sand, to shallow, only slightly sandy soils. Grassland variants on the latter grade into *Themeda-Hyparrhenia* Grassland. Several of the soils are characterised by poor drainage and a markedly fluctuating water table, so that during the wet season numbers of flushes or small springs may be found, but in the dry season they may become extremely dry. The moist areas of summer have numerous hygrophilous grasses and sedges, such as *Andropogon appendiculatus*, *A. eucomus*, *Fimbristylis complanata* and *Pycreus spp.* Shallow soils, on which xerophytic grassland variants are found, may overlie ferruginous lateritic strata along the crests of undulations. The strata may also occur in thick bands around vlei areas.

Physiognomy and structure: A feature of the *Tristachya-Digitaria* Grassland is the absence of primary woody plants. But *Acacia karroo-A. nilotica* Thorn Veld, *A. caffra* Scrub and Tree Veld and *Diospyros lycioides* Scrub, may extend into *Tristachya-Digitaria* Grassland along dongas and other secondary areas.

Tristachya-Digitaria Grassland is relatively short, with a lower stratum of short bunch, rhizomatous and stoloniferous grasses, less than 1·5 ft high, and a mid-grass stratum, from 1·5 to 3 ft high. An upper bunch grass stratum, from 2·5 to 5 ft high, is poorly developed, occurring in secondary communities of *Hyparrhenia hirta*, in moister areas and in the Transitional Faciation (see floristic and ecological variants) where *Andropogon spp.* are more abundant. The lower stratum is still further shortened by sheep grazing and autumn burning.

Composition: Common to abundant and dominant grasses are:

Tristachya hispida	Eragrostis chloromelas (D)
Digitaria tricholaenoides	E. capensis
Eragrostis racemosa	Heteropogon contortus
Elyonurus argenteus	

Occasional to frequent, or locally dominant grasses are:

Alloteropsis semialata (M)	Eragrostis curvula
Andropogon amplectens (M)	E. gummiflua
A. eucomus	Harpechloa falx (M)
A. schirensis (M)	Loudetia simplex
Aristida barbicollis (D)	Microchloa caffra
Brachiaria filifolia	Monocymbium ceresiiforme (M)
B. serrata	Panicum natalense (M)
Cymbopogon excavatus (M)	Setaria nigrirostris
C. plurinodis (D)	Sporobolus stapfianus
Cynodon dactylon	Themeda triandra
Digitaria monodactyla	Trachypogon spicatus
	Urelytrum squarrosum

M = Species mainly of Transitional Faciation or moist areas (see floristic variants)

D = Species mainly of Dry or Typical Faciation (see floristic variants)

Secondary species appearing occasionally in relatively undisturbed veld, or as indicators of past disturbance, are:

Aristida junciformis	Imperata cylindrica
Eragrostis plana	Sporobolus capensis
Hyparrhenia hirta	S. pyramidalis

* Professor J. D. Scott has informed me that *Hyparrhenia hirta* invasion into the Highlands Region around Ntabamhlope and Mooi River was apparent after 1936.

As a result of heavy grazing and autumn burning there is an increase in the abundance of:

Aristida spp.	Eragrostis spp.
Cynodon dactylon	Sporobolus spp.
Elyonurus argenteus	

Floristic and ecological variants: Two faciations may be recognised:

(i) *The Dry Faciation.* This comprises the greater part of *Tristachya-Digitaria* Grassland, occurring chiefly in the vicinity of the Buffalo River under a mean annual rainfall of 601 mm. to 750 mm. Soils are very sandy to only slightly so. Shallow, ferruginous hardpan soils are frequent where the mean annual rainfall is over 700 mm. Encroachment by *Acacia karroo* and *A. nilotica* occurs on eroded, sandy, claypan soils, chiefly in the Utrecht and Wasbank Valley areas with a mean annual rainfall less than 750 mm.

(ii) *The Transitional Faciation.* This Faciation occurs on even topography, mainly to the west of Newcastle, under a mean annual rainfall of 750 mm. to 1,000 mm. Soils are principally sandy fersiallitic types. The Faciation is marked physiognomically by the prominence of the mid-grass stratum and, to a lesser degree, of an upper bunch grass stratum. Floristically there is an increase in abundance of *Themeda triandra*, *Andropogon spp.*, *Monocymbium ceresiiforme* and grasses common to abundant in the Highlands Region and Moist Transitional *Themeda-Hyparrhenia* Grassland.

Four edaphic variants of *Tristachya-Digitaria* Grassland are tentatively recognised:

(i) *Deep, Very Sandy Soil Variants.* These poor, sandy soils, often over 5 ft deep, occur mainly along the Buffalo River and in the Wasbank and Sundays River valleys. These grassland variants are regarded as the typical *Tristachya-Digitaria* Grassland, with *Tristachya hispida* and *Digitaria tricholaenoides* as the dominant species. *Themeda triandra* is sparse to absent.

(ii) *Transitional, Finer Textured Soil Variants.* On these soils, often sandy, claypan types, *Tristachya-Digitaria* Grassland is transitional to *Themeda-Hyparrhenia* Grassland on elevated, better drained soils. Floristically there is an increase in the relative abundance of *Themeda triandra.*

(iii) *Shallow Soil Variants.* On shallow soils, often over laterite, and less than one foot deep, *Eragrostis spp.*, *Aristida spp.*, *Cynodon dactylon* and *Microchloa caffra* are frequent to abundant.

(iv) *Seasonally Moist, Impeded Drainage Variants.* On seasonally moist and badly drained soils, species such as *Imperata cylindrica*, *Andropogon eucomus*, *A. appendiculatus* and Cyperaceae spp., are prominent.

Discussion: Tristachya-Digitaria Grassland represents an extensive, edaphic grassland, developed under climatic conditions similar to those of *Themeda-Hyparrhenia* Grassland.

Controlling edaphic factors appear to be the poor nutrient status of the sandy soils and, in some places, the impeded drainage of soil moisture. On dolerite soils and on steep topography, *Themeda-Hyparrhenia* Grassland, *Acacia karroo-A. nilotica* Thorn Veld, *A. caffra* Scrub and Tree Veld and *Diospyros lycioides* Scrub are found. Secondary scrub encroachment by *A. karroo*, *A. nilotica*, *A. sieberiana* and *Diospyros lycioides* occurs chiefly along dongas in sandy claypan soils, after there has been an improvement in soil drainage.

The principal secondary factors modifying *Tristachya-Digitaria* Grassland are selective grazing, particularly from extensive sheep grazing, and autumn veld burning. These are largely responsible for the present day short grass cover and secondary abundance of *Eragrostis spp.*, *Elyonurus argenteus*, *Aristida junciformis*, *Sporobolus spp.* and *Cynodon dactylon* (Photos. 83–86). In heavily populated Bantu areas, there is a breakdown of the grass cover resulting in wind and sheet erosion of soils.

(c) HYPARRHENIA SPP. TALL GRASS COMMUNITIES

Communities dominated by tall bunch grasses, from 5 to 8 ft high, are common in the Interior Basins Region south of the Biggarsberg, becoming less frequent northwards and in the Uplands and Coast Regions. They occur on alluvial river banks, on boulder beds of streams and rivers, on forest margins, in forest precursor scrub and on the margins of Mesophytic Kloof and Rocky Hillside Scrub and Scrub-forest (Chapter 6). They are found under drier conditions than are *Cymbopogon-Miscanthidium* Tall Grass Communities (section 7.4).

Secondary *Hyparrhenia* Communities are common around cultivation, along roadsides and in old dongas. Secondary as well as primary communities are established mainly on deep soils, such as alluvium and soils banked up on roadsides, but may also occur on dolerite outcrops where there is some protection from burning, grazing and trampling. When heavily grazed and trampled, *Hyparrhenia* Tall Grass Communities are replaced by medium height bunch grasslands.

Dominant species in the communities are:

Hyparrhenia aucta	H. cymbaria (Midland
H. tamba	and Coast Regions)

H. hirta is occasional to frequent and, on forest margins

there are also bracken, forest precursor shrubs and tall herbs (Chapters 5 and 8).

7.4 Moist Grasslands

Moist or 'Sour' Grasslands cover approximately 2,590 square miles, or 23% of the Tugela Basin, in the Coast Hinterland and Uplands Regions between 1,500 ft and 6,500 ft altitude (including *Protea* Savanna and Secondary *Aristida junciformis* Grasslands). The mean annual rainfall is over 750 mm., usually over 875 mm., to more than 1,500 mm. Mists occur commonly, reaching their highest frequency in the Midland Mist Belt Region and their lowest frequency on the Balelesberg. Maximum temperatures are lower than for the Dry, Transitional and Savanna Type Grasslands (section 7.3), as are the minimum temperatures also for the grasslands of the Highlands Region (Chapter 2). The climatic climax vegetation in areas covered by Moist Grasslands is Semi-coast or Uplands Forest, or a preclimax forest where the mean annual rainfall is below about 850 mm. Much of the forest has recently been converted to grassland as a result of fire and disturbance.

(A) SEMI-COAST MIXED THEMEDA GRASSLAND

(Equivalent to part of the Open Bush, Sandy of Pentz (1940, 1945), and *Themeda* veld in the Ngongoni Veld of Acocks (1953).)

Distribution and general ecology: Semi-coast Mixed *Themeda* Grassland occurs in the Coast Hinterland Region between 2,500 and 3,500 ft altitude on generally steep country. As a result of veld management practices, however, it has been replaced by Semi-coast Secondary *Aristida junciformis* Grassland (see Map 1 and section 7.5), leaving few relics. Towards the coast, below 2,500 ft altitude where it is absent today, Mixed *Themeda* Grassland probably formed a field layer to the Semi-coast Bush Clump-Grassland Mosaic (Chapter 5).

In Semi-coast Mixed *Themeda* Grassland, temperatures are higher, frosts are less and the rainfall is better distributed throughout the year than for other grasslands in the Tugela Basin (Chapter 2). The mean annual rainfall is from 801 mm. to 1,250 mm., and mists are frequent. Light frosts occur on flat areas.

Soils are chiefly acid, leached types, differing according to their parent materials. Poor, sandy, usually shallow soils are derived from the Table Mountain Series (see Fig. 2). Coarse, granular, deep soils are obtained from Archaean Granite, and heavier soils from the Karroo and Dominion Reef Systems.

Physiognomy and structure: Relics of Semi-coast Mixed *Themeda* Grassland indicate that this community was taller and more scrubby, with more forbs and shrubs than are found in Moist Grasslands at higher altitudes, where winter temperatures are lower and the frequency and intensity of fires are greater. An upper bunch grass stratum, 3 to 6 ft high, represented by *Cymbopogon spp.*, *Eulalia villosa* and *Digitaria diagonalis*, is prominent but discontinuous. The continuous stratum is the mid-grass stratum, from 2 to 3 ft high, in which *Themeda triandra* is one of the principal species. A lower stratum of short bunch, rhizomatous and stoloniferous grasses, less than 1 ft high, is sparse except on shallow or sandy soils and in disturbed areas. In well preserved relics the density of the grasses appears higher than in grasslands of the Uplands Regions.

Composition: Common to abundant and dominant grasses are:

Themeda triandra	Digitaria diagonalis
Tristachya hispida	Trachypogon spicatus
Heteropogon contortus	Eragrostis racemosa
Andropogon amplectens	E. capensis

Occasional to frequent and locally dominant grasses are:

Alloteropsis semialata	Eulalia villosa
Andropogon appendiculatus	Harpechloa falx
A. schirensis	Loudetia simplex
Brachiaria serrata	Microchloa caffra
Ctenium concinnum	Monocymbium ceresiiforme
Cymbopogon excavatus	Panicum aequinerve
C. validus	Rendlia altera
Elyonurus argenteus	Schizachyrium semiberbe
Eragrostis curvula	Setaria nigrirostris
	S. sphacelata

Secondary species, appearing occasionally to frequently in relatively undisturbed grassland, or as indicators of past disturbance, are:

Aristida junciformis	Sporobolus capensis
Eragrostis plana	Hyparrhenia hirta
Sporobolus pyramidalis	

Discussion: The area formerly occupied by Semi-coast Mixed *Themeda* Grassland is mainly in the Bantu Reserves, where there is heavy stocking and veld burning at all times of the year. Under these conditions, there has been a complete replacement of *Themeda triandra* by the secondary species, *Aristida junciformis*. Encroachment by the introduced Black Wattle, *Acacia mearnsii*, also occurs. On a few farms in the Nkandla district *Themeda* veld has been maintained by good veld management.

(B) MIST BELT THEMEDA GRASSLAND

(Equivalent to grassland in Temperate Forest agro-ecological region of Pentz (1945), and *Themeda* veld in Natal Mist Belt Ngongoni Veld of Acocks (1953).)

Distribution and general ecology: Mist Belt *Themeda*

Photo. 59. Older *Acacia karroo-A.nilotica* thicket adjacent to that in Photo. 58. Stock movement, grazing and trampling under taller trees and shrubs is evident, resulting in poor grass cover, absence of shade tolerant field layer, and erosion.

Photo. 60. Root system of a young *Acacia karroo* in claypan soil with numerous calcareous nodules evident. Note strong tap root and spreading, superficial lateral roots in direct competition with the grass root zone. Rensberg grant, Mimans River valley, Estcourt District.

there are also bracken, forest precursor shrubs and tall herbs (Chapters 5 and 8).

7.4 Moist Grasslands

Moist or 'Sour' Grasslands cover approximately 2,590 square miles, or 23% of the Tugela Basin, in the Coast Hinterland and Uplands Regions between 1,500 ft and 6,500 ft altitude (including *Protea* Savanna and Secondary *Aristida junciformis* Grasslands). The mean annual rainfall is over 750 mm., usually over 875 mm., to more than 1,500 mm. Mists occur commonly, reaching their highest frequency in the Midland Mist Belt Region and their lowest frequency on the Balelesberg. Maximum temperatures are lower than for the Dry, Transitional and Savanna Type Grasslands (section 7.3), as are the minimum temperatures also for the grasslands of the Highlands Region (Chapter 2). The climatic climax vegetation in areas covered by Moist Grasslands is Semi-coast or Uplands Forest, or a preclimax forest where the mean annual rainfall is below about 850 mm. Much of the forest has recently been converted to grassland as a result of fire and disturbance.

(A) SEMI-COAST MIXED THEMEDA GRASSLAND

(Equivalent to part of the Open Bush, Sandy of Pentz (1940, 1945), and *Themeda* veld in the Ngongoni Veld of Acocks (1953).)

Distribution and general ecology: Semi-coast Mixed *Themeda* Grassland occurs in the Coast Hinterland Region between 2,500 and 3,500 ft altitude on generally steep country. As a result of veld management practices, however, it has been replaced by Semi-coast Secondary *Aristida junciformis* Grassland (see Map 1 and section 7.5), leaving few relics. Towards the coast, below 2,500 ft altitude where it is absent today, Mixed *Themeda* Grassland probably formed a field layer to the Semi-coast Bush Clump-Grassland Mosaic (Chapter 5).

In Semi-coast Mixed *Themeda* Grassland, temperatures are higher, frosts are less and the rainfall is better distributed throughout the year than for other grasslands in the Tugela Basin (Chapter 2). The mean annual rainfall is from 801 mm. to 1,250 mm., and mists are frequent. Light frosts occur on flat areas.

Soils are chiefly acid, leached types, differing according to their parent materials. Poor, sandy, usually shallow soils are derived from the Table Mountain Series (see Fig. 2). Coarse, granular, deep soils are obtained from Archaean Granite, and heavier soils from the Karroo and Dominion Reef Systems.

Physiognomy and structure: Relics of Semi-coast Mixed *Themeda* Grassland indicate that this community was taller and more scrubby, with more forbs and shrubs than are found in Moist Grasslands at higher altitudes, where winter temperatures are lower and the frequency and intensity of fires are greater. An upper bunch grass stratum, 3 to 6 ft high, represented by *Cymbopogon spp.*, *Eulalia villosa* and *Digitaria diagonalis*, is prominent but discontinuous. The continuous stratum is the mid-grass stratum, from 2 to 3 ft high, in which *Themeda triandra* is one of the principal species. A lower stratum of short bunch, rhizomatous and stoloniferous grasses, less than 1 ft high, is sparse except on shallow or sandy soils and in disturbed areas. In well preserved relics the density of the grasses appears higher than in grasslands of the Uplands Regions.

Composition: Common to abundant and dominant grasses are:

Themeda triandra	Digitaria diagonalis
Tristachya hispida	Trachypogon spicatus
Heteropogon contortus	Eragrostis racemosa
Andropogon amplectens	E. capensis

Occasional to frequent and locally dominant grasses are:

Alloteropsis semialata	Eulalia villosa
Andropogon appendiculatus	Harpechloa falx
A. schirensis	Loudetia simplex
Brachiaria serrata	Microchloa caffra
Ctenium concinnum	Monocymbium ceresiiforme
Cymbopogon excavatus	Panicum aequinerve
C. validus	Rendlia altera
Elyonurus argenteus	Schizachyrium semiberbe
Eragrostis curvula	Setaria nigrirostris
	S. sphacelata

Secondary species, appearing occasionally to frequently in relatively undisturbed grassland, or as indicators of past disturbance, are:

Aristida junciformis	Sporobolus capensis
Eragrostis plana	Hyparrhenia hirta
Sporobolus pyramidalis	

Discussion: The area formerly occupied by Semi-coast Mixed *Themeda* Grassland is mainly in the Bantu Reserves, where there is heavy stocking and veld burning at all times of the year. Under these conditions, there has been a complete replacement of *Themeda triandra* by the secondary species, *Aristida junciformis*. Encroachment by the introduced Black Wattle, *Acacia mearnsii*, also occurs. On a few farms in the Nkandla district *Themeda* veld has been maintained by good veld management.

(B) MIST BELT THEMEDA GRASSLAND

(Equivalent to grassland in Temperate Forest agro-ecological region of Pentz (1945), and *Themeda* veld in Natal Mist Belt Ngongoni Veld of Acocks (1953).)

Distribution and general ecology: Mist Belt *Themeda*

Photo. 59. Older *Acacia karroo-A.nilotica* thicket adjacent to that in Photo. 58. Stock movement, grazing and trampling under taller trees and shrubs is evident, resulting in poor grass cover, absence of shade tolerant field layer, and erosion.

Photo. 60. Root system of a young *Acacia karroo* in claypan soil with numerous calcareous nodules evident. Note strong tap-root and spreading, superficial lateral roots in direct competition with main grass root zone. Rensbergspruit, Bushmans River valley, Estcourt district.

Photo. 61. Acacia sieberiana Tree Veld, with continuously and fairly heavily grazed *Themeda-Hyparrhenia* grass stratum, on sandy soils near Waterval Farm, Colenso district.

Photo. 62. Interior *Acacia caffra* Scrub at 4,500 ft altitude on steep, north facing, rocky dolerite hill between Utrecht and Noyeesboom. Other tree and shrub species shown are: *Cussonia spicata* (upper left centre), *Aloe marlothii*, *Diospyros lycioides* (foreground), *Rhus rehmanniana* (centre), and *Acacia karroo* (right centre foreground).

Photo. 63. Transitional Valley Vegetation and Semi-coast Forest complex on steeply folded Insuzi Series of rugged Insuzi River valley. Principal communities shown are: (*a*) Semi-coast Mixed *Acacia caffra* Scrub on south aspects. (*b*) Mesophytic Scrub on steep south aspects and in kloofs. (*c*) Relics of *Acacia sieberiana* Tree Veld on alluvial soils. (*d*) Secondary *Aristida junciformis* Grassland above valley with Mist Belt Mixed *Podocarpus* Forest outliers of Qudeni Forest on far hills. Note manner in which woody vegetation occurs mainly on rocky, very steep slopes and in kloofs, whereas grassland occurs on gentler slopes and deeper soils. Woody vegetation has also been cleared by Bantu, as in right centre. View north-west above Insuzi Drift between Nkandla and Qudeni.

Photo. 64. Extensive secondary shrub community of *Euclea crispa* in foreground invading old field with grass cover of *Cynodon dactylon*. Taller trees of *Combretum apiculatum* and *Acacia caffra*. Gunjana area between Tugela Ferry and Sundays River.

Grassland extends from 3,500 to 4,500 ft in the Qudeni and Kranskop-Greytown areas in the Midland Mist Belt Region (Chapter 1). Topography is mainly steep and hilly, overlooking the Valley Region. Mean annual rainfall is mainly from 900 mm. to over 1,500 mm. near the summit of Qudeni. Heavy mists are characteristic and important. Maximum and minimum temperatures are lower than in the adjoining Coast Hinterland, with occasional to frequent moderately severe frosts (Chapter 2). Soils are similar to those of the Highlands Region (see (c)).

Physiognomy and structure: Physiognomically and floristically Mist Belt *Themeda* Grassland resembles *Themeda-Trachypogon* Highlands Grassland. An upper bunch grass stratum, over 3 ft high, is not as prominent as in Semi-coast Mixed *Themeda* Grassland, and a mid-grass stratum, 1·5 to 2·5 ft high, composed principally of *Themeda triandra*, is the continuous stratum. A lower stratum of short bunch, rhizomatous and stoloniferous grasses, less than 1·5 ft high, though more evident than in Semi-coast Mixed *Themeda* Grassland, is generally not well developed except on shallow soils and as a result of heavy grazing. Basal cover appears higher than in *Themeda-Trachypogon* Highlands Grassland.

Composition: Common to abundant and dominant grasses are:

Themeda triandra	Trachypogon spicatus
Tristachya hispida	Eragrostis racemosa
Monocymbium ceresiiforme	E. capensis

In well preserved relics, *Themeda triandra* dominance is marked.

Occasional to frequent or locally dominant grasses are:

Alloteropsis semialata	Festuca scabra
Andropogon amplectens	Harpechloa falx
A. appendiculatus	Helictotrichon turgidulum
A. filifolius	Heteropogon contortus
A. schirensis	Koeleria cristata
Brachiaria serrata	Loudetia simplex
Ctenium concinnum	Microchloa caffra
Cymbopogon excavatus	Panicum ecklonii
C. validus	Rendlia altera
Digitaria diagonalis	Setaria nigrirostris
D. trieholaenoides	S. sphacelata
Elyonurus argenteus	Sporobolus centrifugus
Eragrostis curvula	Stiburus alopecuroides
	S. conrathii

Secondary species, found occasionally to frequently in relatively undisturbed grassland, or as indicators of past disturbance, are:

Aristida junciformis	Sporobolus pyramidalis
Eragrostis plana	S. capensis
	Hyparrhenia hirta

Discussion: Because of its occurrence at cooler, higher altitudes less favoured by the Bantu for settlement, relics of Mist Belt *Themeda* Grassland are more frequent than those of Semi-coast Mixed *Themeda* Grassland. Nevertheless, the Mist Belt Grassland has also to a large extent been replaced by *Aristida junciformis* as a result of burning and grazing practices (see section 7.5).

On account of forest destruction, Mist Belt *Themeda* Grassland has, in recent times, replaced much of the climatic climax Mist Belt Mixed *Podocarpus* Forest, forming a relatively stable community maintained by fire. As a result of colder and drier winters and more frequent exposure to hot, dry north-west winds, grass fires in the Uplands are more frequent and severe than in the milder Coast Hinterland Region. These conditions contribute to Mist Belt *Themeda* Grassland being a more stable grassland than Semi-coast Mixed *Themeda* Grassland, a feature found generally for grasslands of the Uplands and Interior Basins Regions compared with those of the Coast Regions.

(c) THEMEDA-TRACHYPOGON HIGHLANDS GRASSLAND

(Equivalent to the Highland Sourveld of Pentz (1940, 1945) and Acocks (1953).

Distribution and ecology: This Grassland occurs at altitudes between 5,400 and 6,500 ft, covering 1,280 square miles, or 11% of the Tugela Basin. It extends eastwards from the Drakensberg, via the Biggarsberg and Southern Highlands, to the Greytown area and summit of the Qudeni-Nqutu Range (see Map 1).

The mean annual rainfall is from 801 mm. to 1,500 mm., but from 1,251 mm. to 1,500 mm. rainfall occurs only at the highest altitudes (Fig. 8). Mists are frequent, especially on the summits of high hills and spurs. Light frosts may occur in summer, and severe frosts have been recorded for six months of the year. Frosts are more severe on level and concave topography than on sloping ground. A cool, dry season is well defined (see Chapter 2).

Soils are relatively deep, but shallow soils occur on steep slopes and on the crests of undulations. The soils are acid, leached, ferrallitic types from dolerite and sedimentary formations. Because of their leached character, the fertility of the soils is low, but their physical properties are favourable (see Chapter 3).

Physiognomy and structure: Themeda-Trachypogon Highlands Grassland (Photos. 87, 88, 90–92, 94) is dominated by relatively short bunch grasses up to

3·5 ft high. An upper bunch grass stratum, from 2 to 3·5 ft high, is discontinuous and represented chiefly by *Trachypogon spicatus*. The typical grassland character is given by the continuous, mid-grass stratum, 1·5 to 2 ft high, of *Themeda triandra*, *Tristachya hispida* and various other species. A lower stratum of short bunch, rhizomatous and stoloniferous grasses, less than 1·5 ft high, is discontinuous and important chiefly on shallow soils and as a result of disturbance. The basal cover is higher than in Dry Savanna Type Grassland (section 7.3), determinations by West (1951) on undisturbed veld at the Ntabamhlope Research Station averaging 42·8%, ranging from 24% to 57%.

Composition: Common to abundant and dominant grasses are:

Themeda triandra	Monocymbium ceresiiforme
Tristachya hispida	Andropogon filifolius
Trachypogon spicatus	Eragrostis racemosa
Heteropogon contortus	E. capensis

Occasional to frequent or locally dominant grasses are:

Alloteropsis semialata	Festuca costata (UT)
Andropogon amplectens	F. scabra
A. appendiculatus	Harpechloa falx
A. distachyus (UT)	Helictotrichon hirtulum
A. schirensis	H. turgidulum
Brachiaria serrata	Ischaemum franksiae (UT)
Bromus speciosus (UT)	Koeleria cristata
Cymbopogon excavatus	Loudetia simplex
C. validus	Microchloa caffra
Digitaria diagonalis	Panicum ecklonii
D. monodactyla	P. natalense
D. setifolia	Rendlia altera
D. tricholaenoides	Setaria nigrirostris
Elyonurus argenteus	Sporobolus centrifugus
Eragrostis curvula	Stiburus alopecuroides
Eulalia villosa	Pentaschistis tysonii (UT)

UT = species occurring at the upper temperate altitudes (see floristic variants).

Secondary species found occasionally in relatively undisturbed grassland, or as indicators of past disturbance, are:

Eragrostis plana	Hyparrhenia hirta
Sporobolus pyramidalis	Aristida junciformis
S. capensis	

Where the Grassland is heavily grazed, *Trachypogon spicatus* is one of the first important species to disappear. *Eragrostis spp.* and *Sporobolus spp.* increase, as does also *Elyonurus argenteus* as a result of grazing by sheep. Where the primary grass cover is broken because of disturbance, *Hyparrhenia hirta* is prominent. Forbs such as *Helichrysum aureonitens* and bracken (*Pteridium aquilinum*) also increase under poor veld management. Under heavy disturbance leading to complete breakdown of the grass cover, such as is found in the Bantu Reserve below the Giants Castle Game Reserve, low shrubs such as *Aster filifolius* become dominant. On the Qudeni-Nqutu range under these conditions, *Cliffortia repens* becomes dominant (Chapter 8, Photos. 94, 96).

Floristic variants: Five climatic Faciations of *Themeda-Trachypogon* Highlands Grassland may be distinguished.

(i) *The Southern and South-western Faciation* is the most extensive Faciation, extending from Van Reenens Pass to the southern boundary of the Tugela Basin, and eastwards to the Mooi River-Nottingham Road area. Extensions occur further east on the high 5,000 ft area overlooking the Karkloof. Topography over much of the Faciation is flat or undulating. *Themeda triandra* and *Trachypogon spicatus* are the principal species of the grassland.

(ii) *The Low Drakensberg and Biggarsberg Faciation* extends northwards from the Van Reenens Pass area to the Bothas Pass area, north-west of Newcastle, and eastwards along the Biggarsberg to near Dundee. The Faciation shows affinities with the eastern Orange Free State grasslands. It is a relatively short, mid-grass community, and *Trachypogon spicatus* is not prominent, features accentuated by a history of autumn burning and sheep grazing.

(iii) *The Eastern Transitional Midland Faciation* occurs from Rietvlei to near Greytown, in the Helpmekaar area, on the Msinga summit and on the Qudeni-Nqutu Range. Forest relics and forest precursor communities show affinities with those of the Midland Mist Belt (Chapter, 8) while the grassland shows affinities with Mist Belt *Themeda* Grassland. Where the veld is relatively undisturbed, *Themeda* dominance is marked. The grassland is generally short as a result of sheep grazing in these areas.

(iv) *The Upper Protea Savanna Faciation.* At altitudes over 5,500 ft, the grass stratum of *Protea* Savanna and the adjacent grassland (see Chapter 8 and Map 1) are transitional from Highlands Grassland to Subalpine Grassland (Chapter 9). The mean annual rainfall is from 1,175 mm. to over 1,250 mm. *Ischaemum franksiae* and temperate species, such as *Festuca costata*, *Alloteropsis semialata*, *Bromus speciosus* and *Pentaschistis tysonii*, are abundant.

(v) *Transitional Dry Faciation.* The Faciation is transitional to *Themeda-Hyparrhenia* Grassland of the Interior Basins Region, occurring at drier altitudes below 5,000 ft and where local climatic conditions are warmer and drier. The Faciation thus occurs in deep

valleys along the foot of the High Drakensberg, in rain-shadow areas and at the lower altitudinal limits of Highlands Grassland. Mean annual rainfall is from 750 mm. to 900 mm. and mists are less frequent than in the other Faciations. *Hyparrhenia hirta* is abundant on disturbed areas and readily invades the Highlands Grassland.

Five main edaphic and topographic variants are distinguished within the Faciations.

(i) *Dolerite Soils Variant.* Dolerite soils are common and are structurally more favourable to plant growth than soils derived from sedimentary rocks. The grassland is characterised by a higher basal cover and density than that on sedimentary soils. Dominance by *Themeda* is marked and the grass cover is more stable, breaking down less readily under excessive grazing.

(ii) *Sedimentary Derived Soil Variants.* Grass cover, density and height are lower, while the lower stratum of short bunch, rhizomatous and stoloniferous grasses is more important than in Dolerite Soil Variants. The grass cover on clayey shale derived soils is most sensitive to disturbance. On soils derived from mixed dolerite and sedimentary rock materials, the grassland shows features intermediate between the Dolerite Soils Variant and Sedimentary Derived Soils Variants.

(iii) *Moist Soil Variants.* On moister soils, the grassland is transitional to Hygrophilous Grass and Sedge Meadow (section 7.1), being essentially a late hydrosere stage. Moist Soil Variants are characterised by occasional to frequent hygrophilous grasses, such as *Andropogon appendiculatus*, *E. planiculmis*, *Agrostis lachnantha* and *A. huttoniae*, and sedges, such as *Bulbostylis spp.*, *Fimbristylis spp.* and *Pycreus spp.*

(iv) *Slope Aspect Variants.* On the cool, moist, south facing steep slopes, grasses are taller and coarser, with the tall bunch grasses of *Cymbopogon spp.*, *Hyparrhenia spp.* prominent. The Variants frequently represent secondary successional stages of a destroyed forest. On dry, warm, north facing slopes, grasses are shorter, with the lower stratum of short bunch, rhizomatous and stoloniferous grasses more prominent than on level ground and on south facing slopes. At higher altitudes, temperate species such as *Festuca costata* are abundant on south facing slopes, whereas on north slopes tropical species such as *Themeda triandra* and *Trachypogon spicatus* remain dominant. Preferences by grazing animals for the grasses on north facing slopes frequently result in overgrazing and soil erosion.

(v) *Shallow Soil Variants.* On shallow soils less than one foot deep, the grass cover is shorter and more xerophytic, with rock outcrop and shallow soil species such as *Eragrostis spp.*, *Aristida spp.*, *Microchloa caffra* and *Digitaria monodactyla* prominent. Shallow Soil Variants are connected by all stages of transition to grassland on deep soils. Successionally they may be regarded as the link between xerosere communities and primary grassland. Under heavy grazing the grass cover breaks down rapidly, especially on shallow shale soils, resulting in erosion and in encroachment by secondary species.

Discussion: In common with other major Moist Grassland associations, *Themeda-Trachypogon* Highlands Grassland is a fire maintained climax. Where fire is either absent or reduced in effect by topography or other factors, there is a development to Mountain *Podocarpus* Forest, especially along the steep slopes of the Drakensberg. The effects of the cold, dry winters of the Highlands Region, together with hot, dry Berg winds in late winter and spring, are to make the grasslands inflammable and thus to maintain them. The Highlands Region has the lowest ratio of forest to grassland of any moist region in the Tugela Basin (Map 1).

(D) THEMEDA-TRISTACHYA-DIGITARIA NORTHERN HIGHLANDS GRASSLAND

Distribution and general ecology: This Grassland occurs on flat to steeply rolling topography at altitudes from 5,000 to over 6,500 ft along the Northern Highlands. It extends eastwards from the Volksrust area to the upper Blood River area, covering approximately 510 square miles, or 4·5% of the Tugela Basin (Map 1). The Grassland is equivalent to part of Highland Sourveld (Pentz, 1945), and to the Near Highland Sourveld Variation of North-eastern Sandy Highveld (Alcocks, 1953). A few small, transitional grasslands of the Transvaal and Orange Free State High Veld, that extend into the Tugela Basin, are included here.

Temperatures in the Northern Highlands Grassland are similar to those of *Themeda-Trachypogon* Highlands Grassland. The mean annual rainfall is from 701 mm. to 1,250 mm., with from 1,001 mm. to 1,250 mm. only at the highest elevations (Fig. 8). The poor, often sandy, shallow soils are derived from the Ecca and the Beaufort Series. Dolerite soils occur locally.

Physiognomy and structure: *Themeda-Trachypogon-Digitaria* Grassland is a relatively short community in which the mid-bunch grass stratum, 1·5 to 2 ft. high, is continuous, together with the lower stratum of short bunch, rhizomatous and stoloniferous grasses less than 1·5 ft high. Upper bunch grass stratum species over 2·5 ft high are localised.

Composition: Common to abundant and dominant grasses are:

Themeda triandra	Eragrostis racemosa
Tristachya hispida	Heteropogon contortus
Digitaria tricholaenoides	Eragrostis capensis

Occasional to frequent or locally dominant grasses are:

Alloteropsis semialata	Festuca scabra
Andropogon amplectens	Harpechloa falx
A. appendiculatus	Koeleria cristata
A. filifolius	Loudetia simplex
A. schirensis	Microchloa caffra
Brachiaria serrata	Monocymbium ceresii-forme
Cymbopogon excavatus	
C. validus	Panicum ecklonii
Elyonurus argenteus	P. natalense
Eragrostis chloromelas	Rendlia altera
E. curvula	Setaria nigrirostris
	Trachypogon spicatus

Secondary species found occasionally to frequently in relatively undisturbed grassland, or as indicators of past disturbance, are:

Eragrostis plana	Sporobolus capensis
Sporobolus pyramidalis	Aristida junciformis

The Northern Highlands are extensively grazed by sheep and *Elyonurus argenteus* frequently becomes abundant on this account.

Discussion: Themeda-Tristachya-Digitaria Grassland is related to *Themeda-Trachypogon* Grassland. The drier climate (Chapter 2) and sandy, shallow character of the soils in the Northern Highlands appear to account for the differentiation between Grassland in the Northern Highlands and that further south in the Highlands Region.

Themeda-Tristachya-Digitaria Grassland resembles other Moist Grasslands in being fire-maintained. Sparse relics of the climatic climax community indicate it to be a scrub-forest type closely resembling preclimax stages of Mountain *Podocarpus* Forest (Chapter 8).

A secondary feature found frequently in *Themeda-Tristachya-Digitaria* Northern Highlands Grassland is the extensive scrub-encroachment by *Leucosidea sericea* (Photos. 93, 116). This encroachment arises from close grazing and a consequent reduced frequency and intensity of fire (Chapter 8).

(E) CYMBOPOGON-MISCANTHIDIUM TALL GRASS COMMUNITIES

Coarse-leaved, tall bunch grass communities, over 5 ft high, of *Cymbopogon excavatus*, *C. validus* and *Miscanthidium capense*, occur commonly in the Uplands and Coast Regions, and occasionally in Moist Transitional *Themeda-Hyparrhenia* Grassland. Occasional to common associated species are bracken (*Pteridium aquilinum*) and numerous shrubby and herbaceous species of the precursor stages to forest (Chapters 5 and 8).

The communities occur on steep, rocky south aspects, along rocky streambanks, on forest margins and occasionally in the outer zones of vleis, areas where there is a certain amount of protection from fire and disturbance. Isolated communities are sometimes indicative of a former forest patch.

Cymbopogon-Miscanthidium Tall Grass Communities are replaced by shorter grassland when there is frequent burning and trampling by stock.

7.5 Secondary Grasslands

Secondary grasslands may either be limited to areas of disturbance, such as certain farm camps, around lairs and watering points, or they may cover extensive areas, such as the Secondary *Aristida junciformis* Grasslands shown on Map 1. The grasslands are either well defined and dominated by secondary species or they are a mixture of primary and secondary species. All present day primary grasslands contain secondary elements, as is indicated in the descriptions of these grasslands in sections 7.3 and 7.4.

The secondary grasslands arise as a result of grazing, burning and from other forms of human activity. Grazing effects are chiefly due to selective grazing and to continuous overgrazing, with its associated trampling. Secondary effects from burning depend on the frequency and time of burning, and the associated grazing practice. Experimental evidence by Scott (1951) showed a marked deterioration in grass cover from autumn burning, but there was little or no deterioration from burning after the first spring rains. An excessive organic accumulation resulting from complete protection was detrimental to grassland. Burning, at longer intervals than two years, of a considerable organic accumulation, also caused a serious reduction in the grass cover.

Secondary grass communities occur under *relatively* limited disturbance. Where heavy disturbance is maintained, secondary herbs, trees and shrubs become dominant. Encroachment by secondary scrub usually precedes a complete breakdown in grass cover, continued heavy grazing and the competition from the secondary invaders causing a rapid disappearance of the grasses. Grass cover deterioration occurs most easily on stony, shallow soils, and on clayey soils that readily form indurated surfaces.

(A) RUDERAL GRASS COMMUNITIES

Secondary grass communities of annual species occur

in old fields and along roadsides and paths. The early species persist for a few years, becoming invaded by perennial secondary species, such as *Cynodon dactylon*, *Eragrostis spp.* and *Sporobolus spp.*, and eventually by primary grasses.

Typical ruderal grasses found are:

Brachiaria eruciformis (dark turf soils)	Eragrostis ciliaris
Chloris pycnothrix	Panicum laevifolium
C. virgata	Rhynchelytrum repens
Digitaria adscendens	Setaria pallidefusca
D. sanguinalis	S. verticillata
D. horizontalis	Tragus berteronianus
Eleusine indica	T. racemosus

(B) CYNODON DACTYLON GRASSLAND

A short, rhizomatous and stoloniferous sward of *C. dactylon* Grassland is often important in stabilising soils where there is heavy grazing and tramping in the Interior Basins Region (see also section 7.1 and Chapter 6). The communities occur principally on sandy soils, around termitaria and on old lands. They are often important in stabilizing dongas in alluvial soils.

Communities of *C. dactylon* occur also on the manured areas around kraals and in other areas of stock concentration, the species showing a tolerance to high nitrogen concentrations (Roux, 1954; Jong and Roux, 1955).

(C) SECONDARY BUNCH GRASSLANDS

The principal perennial bunch grass species (excluding *Aristida junciformis*, (see (D)) dominating secondary communities are:

Aristida barbicollis	Eragrostis plana
A. bipartita	E. curvula
Bothriochloa insculpta (IB)	E. chloromelas (IB)
B. glabra (IB)	E. heteromera
Hyparrhenia hirta	E. racemosa
H. aucta	E. capensis
H. tamba	E. superba (MV)
Sporobolus pyramidalis	E. lappula (IB)
S. capensis	Elyonurus argenteus

MV = Marginal to Valley Region
IB = Interior Basins Region

Secondary, xeromorphic communities of *Aristida barbicollis* and *A. bipartita* occur on the most severely eroded and xeric habitats (see section 7.2).

Secondary *Hyparrhenia spp.* tall grass communities, especially of the shorter 2·5 to 5 ft *H. hirta*, are common on roadsides and on old fields throughout the Tugela Basin, exeept in the Valley Region and in the Mountain Region (Photo. 86 and section 7.3 (C)).

Bothriochloa spp. Bunch Grass Communities, up to 4·5 ft high, occur commonly on disturbed areas along roadsides, in dongas and around cultivation. The communities take the place of *Hyparrhenia spp.* communities at drier, lower altitudes of the Interior Basins Region and in the Valley Region.

Strongly rooted, densely tufted, rather low bunch grasslands, up to 2·5 ft high, of *Eragrostis plana* and *Sporobolus pyramidalis*, are common in the Coast, Uplands and Interior Basins Regions. The communities form the initial, perennial grass stage in the secondary succession on old cultivation. They are relatively stable communities under heavy grazing and manuring, and are thus indicators of past disturbance. Common associated species are *Eragrostis curvula* and *Sporobolus capensis*.

In veld that is continuously and fairly heavily grazed, as a result of autumn burning and often under sheep grazing, *Eragrostis spp.* are important (Photo. 85). Primary grasses and secondary *Elyonurus argenteus*, *Sporobolus pyramidalis*, *Cynodon dactylon*, or *Aristida spp.*, are occasional to frequent associated grasses. Grazing effects in the communities are evident in their shortness, that is, less than 1 ft to 1·5 ft high, and open character. Forbs, such as *Berkheya onopordifolia* (Photo. 95) and poisonous *Senecio spp.*, may become prominent. Sheet erosion can frequently be seen around the raised grass tufts.

Grassland of the short, fine-leaved, aromatic, coppery tinted buneh grass, *Elyonurus argenteus*, up to 1·5 ft high, occurs frequently in the interior areas of the Tugela Basin, up to over 8,000 ft altitude (Photos. 83, 84). The secondary grassland is widespread in *Tristachya-Digitaria* Grassland, and is often found on ferruginous lateritic soils in the Interior Basins Region.

E. argenteus Grassland is to a large extent consequent upon sheep farming. This holds also under similar conditions in the Border areas of the eastern Cape Province. Selective grazing is apparent in the communities, palatable grasses being grazed short in comparison with the tufts of *E. argenteus*, whose young shoots only are grazed.

(D) SECONDARY ARISTIDA JUNCIFORMIS GRASSLAND

(Equivalent to 'N'kongoni' Veld of Temperate Forest and, in part, to Open Bush Sandy of Pentz (1945); and to Ngongoni Veld and Mist Belt Ngongoni Veld of Acocks (1953). A division into Semi-coast and Mist Belt Secondary *Aristida junciformis* Grassland, in part

similar to that of Acocks (1953), is shown on Map 1 (see following).)

General distribution: Secondary grasslands dominated by *Aristida junciformis* (or 'Ngongoni') extend from near sea level to over 5,000 ft. (See *A. junciformis* in Appendix 2.) (Photos. 9, 15–18, 24, 25, 27, 63, 83.) The grass is dominant in the secondary grass stratum of Coast *Acacia karroo-A. nilotica-A. robusta* Thorn Scrub above 750 ft altitude, in the secondary grass strata of the Semi-coast Bush Clump-Grassland Mosaic and Dry Coast *Acacia karroo-A. nilotica* Thorn Veld, and in the grasslands of the Coast Hinterland and Midland Mist Belt Regions. Secondary communities occur in *Tristachya-Digitaria* Grassland, in *Themeda-Trachypogon* Highlands Grassland and in *Themeda-Tristachya-Digitaria* Northern Highlands Grassland.

The *Aristida junciformis* Grassland of the Coast Hinterland and Midland Mist Belt Regions is shown on Map 1. Although the secondary grassland in both regions is similar, a division has been made into Semi-coast and Mist Belt 'faciations' because of differences in the displaced *Themeda* grasslands (see section 7.4) and in the other vegetation of the two regions. Semi-coast *A. junciformis* Grassland covers 260 square miles, or 2·3% of the Tugela Basin, and in the Mist Belt, 160 square miles, or 1·4% of the Tugela Basin.

Nature of the Grassland: The Grassland is characterised by the 'complete' dominance of the strongly rooted, densely tufted and wire-leaved *A. junciformis*. At ground level, tufts may be over 12 ins in diameter; in height they may exceed 2 ft. In the marginal areas of the Valley Region, and in the Highlands and Interior Basins Regions, *A. junciformis* displays a shorter, smaller tufted, and less vigorous appearance. Where the grassland is not burned annually, growth is rank and dense and the veld completely unpalatable to grazing animals. Only young, green shoots that appear after burning are eaten by stock. Heavy selective grazing of associated more palatable species is prevalent.

General climatic and soil factors: The *A. junciformis* Grasslands have attained their most vigorous development under the misty climates of the Coast Hinterland and Midland Mist Belt Regions, but they occur also under the warm dry climates of the marginal Lower Valley Sub-region and Interior Basins Region, under the warm moist climate of the Coast Lowlands Region, and under the cool humid climate of the Highlands Region (Chapter 2). *A. junciformis* occurs under a mean annual rainfall of 650 mm. to over 1,500 mm.; extreme temperatures range from approximately 40° C to − 5° C. The soils are chemically poor, acid fersiallitic and ferralitic types (Chapter 3), derived largely from sedimentary and metamorphic formations, but occasionally also from igneous dolerite. In the Interior Basins Region, the soils are poor, acid, sandy and ferruginous hardpan types associated with the Middle Ecca Series.

Biotic factors: The widespread secondary dominance of *A. junciformis* is a problem of considerable ecological and economic importance. Its secondary character has long been recognised (Bews, 1912, 1913, 1918; Acocks, 1953; Scott, 1957).

The extensive invasion by *A. junciformis* of the *Themeda* grasslands is of recent origin, a feature confirmed by Bews (1912), who wrote:

'It is extremely important to note how the natural veld associations are changing. Over wide areas *A. junciformis* has more or less completely ousted the more nutritious red grass.'

The spread of *A. junciformis* has followed upon the overall more intensive utilization of the grasslands resulting from European colonization and settlement, and the creation of the Bantu Reserves in the middle of the nineteenth century (Chapter 4). Bews (1912, 1913) considered that early burning, that is in autumn or earlier, had a marked influence.

'Early burning of the grass is the chief cause of the change. If the grass is burned before it is completely withered the *Anthistiria* (*Themeda*) is more affected than the coarse wiry *Aristida* . . . If the grass is burned, as it often is, before the end of the rainy season, a new growth may be obtained even before the winter (dry season) sets in, and the young shoots suffer more than the older ones from the winter frosts and drought. In this connection also *Aristida* is stronger than *Anthistiria*, (1913). 'There seems to be a fairly general consensus of opinion among farmers that burning the veld grass leads to deterioration, i.e. to the *Aristida* association getting the upper hand (1912).'

The deleterious effects of autumn burning on grassland composition have been demonstrated by Scott (1951). Veld burning by pioneer European farmers of the late nineteenth and early twentieth centuries was mainly early burning. Burning at any time of the year was till recently a feature of Bantu areas. Autumn burning is practised by farmers in remoter areas, such as in parts of the Interior Buffalo River Basin, where considerable *A. junciformis* is present today and autumn burning by sheep farmers has long been practised. Only recently has the value and importance of spring burning become generally recognised.

The principal factor responsible for the present-day spread of *Aristida junciformis* (Photo. 83) is the selective grazing of palatable primary grasses such as *Themeda triandra*. This factor arises from the old, and still prevalent, practice of a continuous or non-rotational system of veld management.

Conclusions: The greatest development of *A. junciformis* Grassland is found in the Coast Hinterland and Midland Mist Belt, but the grassland is also found in the Coast Lowlands, Lower Valley Sub-region, Interior Basins and Highlands Regions. The Grassland is associated with poor, acid and often sandy soil types.

The secondary dominance and spread of *A. junciformis* is of recent origin, coupled with the advent of the European, the general restriction of animal movements, the control of stock diseases and introduction of the dipping tank, and the overall intensification of land use within the last hundred years. Under present-day conditions, selective grazing is the prime factor in the spread of *A. junciformis*, which can be expected to increase with greater grassland utilization if present grazing systems are maintained.

7.6 Phenology and Seasonal Variation

Grasslands show marked seasonal variations in the growth and flowering of the various species, five seasonal or phenological phases being distinguishable. The phenology of the associated grassland plants is considered in the following section 7.7.

(i) *Late Autumn and Winter.* From May to August, the late autumn and winter phase is one of dormancy, when frosts and dry weather kill the foliage and bleach the green and brown colours of autumn to white pink and brown. In the Coast Regions, with milder and moister winters, green shoots are invariably present throughout the year. The inflammability of the grasslands in the Uplands and Interior Basins Regions is high and fires are frequent, especially in the latter part of the winter season.

(ii) *Prevernal Aspect.* With the rise in soil temperatures towards the end of August, before the spring rains in September, there is a certain amount of flowering and shooting of various geophytes. One of the earliest is *Gazania longiscapa*. Where the grass cover is dense and tall, soil temperatures are lower than in shorter and more open grasslands, and the onset of the prevernal aspect phase tends to be delayed.

(iii) *Spring Aspect.* After the first spring rains, usually from mid-September to early November, there are marked changes in the grasslands. Burnt areas rapidly become green; numerous plants shoot and flower rapidly before the grasses become tall. In unburnt veld, new shoots are masked for some time by the dead foliage of the winter season. The spring aspect phase is usually short and continuous with the early summer phase, several spring aspect grasses continuing to flower in the summer aspect. Common spring aspect grasses are shorter species such as:

Eragrostis capensis*	Poa binata*
Ischaemum franksiae*	Rendlia altera
Harpechloa falx*	Tristachya hispida*
Microchloa caffra	

Sedges include:

Bulbostylis oretrephes	Fimbristylis mono-
B. schoenoides*	stachyus*

(iv) *Early Summer Aspect.* November to mid-January is the flowering period of a number of grasses, notably *Themeda triandra*. Different intraspecific types of *Themeda* (see section 7.3 (A), floristic and ecological variants) may flower at different periods, however, such as the tall Valley Region form, *T. triandra var. trachyspathea*, which flowers mainly in January or later in the year. Early summer grasses include the taller species:

Alloteropsis semialata	Eragrostis capensis*
Andropogon appendicu-	E. chloromelas*
latus*	E. curvula*
A. eucomus	E. racemosa*
A. filifolius*	Heteropogon contortus*
Aristida galpinii	Festuca costata*
Brachiaria filifolia	Koeleria cristata*
B. serrata*	Panicum ecklonii
Bromus speciosus*	P. natalense*
Digitaria pentzii*	Setaria nigrirostris
D. setifolia	S. sphacelata*
D. tricholaenoides	S. woodii*
Elyonurus argenteus	Sporobolus centrifugus*
Themeda triandra	Urelytrum squarrosum
Tristachya hispida	

Sedges include:

Cyperus compactus	Schoenoxiphium cari-
Scleria bulbifera	coides*

(v) *Late Summer and Autumnal Aspect.* From February to April, the phase is characterised by the flowering of tall associated grassland plants (section 7.7), of the tall *Cymbopogon spp.* and *Hyparrhenia spp.*, and of *Trachypogon spicatus*, *Monocymbium ceresiiforme* and *Hyparrhenia hirta*, the co-dominants of *Themeda triandra* in the extensive grasslands of the Uplands and Interior Basins Regions. Late rains may extend the flowering of *Hyparrhenia spp.* well into autumn, and even to early winter on the coast. Physiologically, the phase is marked by the translocation of plant substances from shoots to roots. The interruption of the process, by practices such

* Species also flowering commonly in subsequent seasonal phase.

as autumn burning, results in a reduced vigour of grass growth (see Weinmann and Scott in Meredith *et al.*, 1955). Late summer grasses include:

Andropogon amplectens	Festuca caprina
A. schirensis	Hyparrhenia aucta
Aristida barbicollis	H. cymbaria
A. bipartita	H. hirta
A. curvata	H. tamba
A. junciformis	Imperata cylindrica
A. monticola	Loudetia simplex
Bothriochloa insculpta	Miscanthidium capense
Chloris gayana	Monocymbium ceresii-forme
Cymbopogon excavatus	Rhynchelytrum repens
C. plurinodis	R. setifolium
C. validus	Sporobolus fimbriatus
Digitaria diagonalis	S. pyramidalis
Eragrostis plana	Trachypogon spicatus
Eulalia villosa	

The five phenological or seasonal phases are not clearly separated, but continue one into the other. Variations are found in growth and flowering optima from year to year, and within limited areas at one particular time of year.

Seasonal aspects are less clearly defined in the Coast Regions, where winters are milder and moister than in the Uplands and Interior Basins Regions. The coast winter is one of limited growth rate, rather than of dormancy and death of foliage from frost and drought.

Though development of the prevernal aspect plants is dependent on increase in soil temperatures (see section 7.7), spring growth of the grasses depends mainly on soil moisture. Early spring rains result in earlier development of the grasses and, if there is no spring or summer drought, there is an earlier development of the subsequent summer phases. When the spring rains are late, the spring and early summer phases tend to be short (see Chapter 2 for rainfall variations). Most grasses on moister, deeper soils develop earlier than those on drier, shallower soils. West (1951) recorded that on experimental plots burned before winter, a long period of frost and insolation adversely affected the grasses, and though flowering began early, leaf growth was much less than on plots burned later.

Despite the variations in the timing and duration of the various seasonal aspects, however, the general sequence of phases remains constant. Awareness of this is essential for good grassland management. Variations in occurrence and duration of the phases must be taken into account if the optimum degree of grassland utilisation is to be obtained.

7.7 Associated Grassland Plants

Associated non-grass plants, or forbs, existing as occasional to frequent and locally abundant constituents of grassland, provide a rich assemblage of plants of considerable botanical interest (listed in Appendix 2). Many of the plants are of economic importance, some early flowering species, for example, are poisonous to stock, providing tempting green growth when grasses are at an unpalatable stage.

Forbs are more frequent in Moist Grasslands than in Dry and Savanna Type Grasslands, occurring chiefly in prevernal, vernal and early summer aspects. Forb development is related to fire and grass competition, and their life form, ecological and phenological relationships fit in with the operation of these factors.

Geophytes and hemicryptophytes, with renewal buds at or below the soil surface, escape burning, and their seasonal development occurs when there is little grass competition. If there is no periodic removal of the grass cover, geophytes and hemicryptophytes decrease in number, as was observed by Bews (1918).

Most geophytes and hemicryptyphytes commence development with the rise in soil temperatures in later winter and after the spring rains, before the main grass growth. Relatively warm winters promote early development of the prevernal aspect flowering plants, as may local climatic conditions. With the daytime high insolation raising soil temperatures at altitudes over 6,000 ft on the High Drakensberg, for example, forbs have been observed flowering in early July where topographic conditions were such as to preclude severe frosts at night. Prevernal aspect plants flower earlier on north-facing slopes than on south slopes.

Allsop (1945) noted that low-growing forbs tended to flower early, when the surrounding grass growth was short in early spring. In short, open grassland, some early flowering forbs, such as *Gazania longiscapa* and *Berkheya setifera*, persisted and flowered continuously from early spring to late autumn. Other forbs, such as *Acalypha punctata*, flowered after the spring rains and died down in late summer. Different species of forbs also exhibited preferences for moist soils or for dry, rocky soils, and for different slope aspects.

Shrubs and many chamaephytes are mainly late summer and autumnal aspect plants, and tend to be fire sensitive since their renewal buds are well above the soil surface. They are thus favoured by the absence, or reduction in the frequency and intensity of fire, occurring where there is protection or a poor grass cover, such as on shallow soils and as a result of grazing. Shrub and chamaephyte forbs are frequently indicative of successional advance to scrub and forest.

Photo. 65. Diospyros lycioides Scrub, protected from fire amongst dolerite rocks, at upper altitudinal limit of 5,000 ft between Utrecht and Noyeesboom. (*D.lycioides* Scrub in altitudinal zone above *Acacia caffra* Scrub shown in Photo. 62.)

Photo. 66. General view south-east from Potela down Lower Tugela Valley, overlooking Jameson's Drift area. Kranskop in distance. Showing extensive cultivation, soil erosion and clearance of Transitional *Acacia karroo-A.nilotica* Thorn Veld on near hillside, and Succulent *Euphorbia tirucalli* Scrub on opposing north facing hillslopes on south side of Tugela River.

Photo. 67. General view west from Umhlumba Neck of extensive soil erosion and secondary vegetation of Weenen area. In foreground a narrow zone, a few hundred yards wide, of *Acacia karroo-A.nilotica* Thorn Veld, forming boundary of Valley Vegetation. In middle and far distance, *Acacia tortilis* and other secondary species with relic trees of Semi-deciduous Bush.

Photo. 68. Eroding hillside, with mutilated relic trees of Semi-deciduous Bush, caused by continuous overgrazing and browsing. Bantu kraals immediately to right of photo.

Photo. 69. Rocky, dolerite hill completely denuded of Semi-deciduous Bush. *Boscia albitrunca* relic in centre. Secondary, stunted, heavily browsed *Acacia tortilis* shrubs on hill. In foreground cultivated land on deep colluvial and alluvial soil. Weenen-Mooi River road.

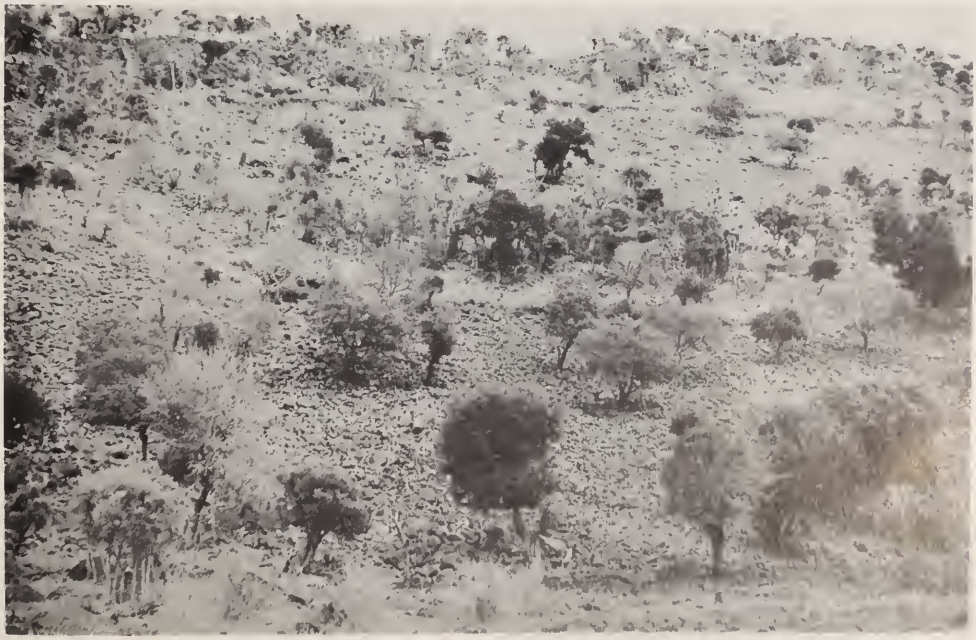


Photo. 70. In heavily populated Inadi River Valley, Ngobevu, Bantu cultivation of steep, rocky dolerite hillside with relic trees in and between lands. Goats browsing can be seen.

Photo. 71. Goats browsing on trees and shrubs of *Acacia tortilis*, *A.nilotica* and *Xeromphis rudis*, giving rise to browse lines on underside of tree canopies, and cushion-shaped shrub forms. Weenen.

Photo. 72. Double browse line on *Boscia albitrunca*. Sloping trunk has enabled goats to climb tree and browse upper, as well as lower crown. Tugela Ferry area.

CHAPTER 8

UPLANDS VEGETATION

Uplands vegetation covers approximately 2,350 square miles, or about 21% of the Tugela Basin, at altitudes between 3,500 ft and 6,500 ft. The vegetation of the Midland Mist Belt Region, from 3,500 ft to 4,500 ft, is limited in extent, covering only some 170 square miles, or 1·5% of the Basin. Above 4,500 ft, the vegetation of the more extensive Highlands Region covers approximately 2,180 square miles.

Most Uplands vegetation consists of grassland, namely, Mist Belt Secondary *Aristida junciformis* Grassland, *Themeda-Trachypogon* Highlands Grassland and *Themeda-Tristachya-Digitaria* Northern Highlands Grassland, described in Chapter 7. The Uplands *Podocarpus* Forests, seral and secondary scrub, are discussed in this Chapter.

8.1 Hygrophilous Vegetation

Aquatic (see Chapter 7) and hygrophilous vegetation in the Uplands Regions occurs along rivers and streams and around vleis and the occasional tarns. As explained in Chapters 5 and 7, woody vegetation commonly occurs along rivers and streams in rocky and rugged areas, whereas around vleis, and along rivers and streams on even topography (see Chapter 7), hygrophilous grass sedge meadows are usual owing to the effects of fires. On the rugged Drakensberg, however, vlei vegetation frequently develops to Tall Herb-*Pteridium aquilinum-Miscanthidium* Tall Grass-Forest Precursor stages (section 8.5).

The hygrophilous woody vegetation, discussed in this chapter, includes only a limited number of truly hygrophilous tree and shrub species. The vegetation is often also composed largely of forest precursors, forest initials and, on rocky streambanks, xerosere rock and cliff scrub species, all the plants enjoying complete or partial protection from fire because of local habitat conditions. *Salix woodii* Scrub, described in Chapter 6, is one of the principal truly hygrophilous scrub communities found in the Uplands Regions as well as at lower altitudes in the Tugela Basin.

(A) OPEN STREAMBANK TREE AND SHRUB COMMUNITIES

Open streambank Tree and Shrub Communities range from scattered individuals to small groups of shrubs and trees.

Common to abundant hygrophilous trees, from 10 to over 40 ft high are (L = Lower; U = Upper; M = Midland Mist Belt Region; H = Highlands Region):

Bowkeria verticillata	Ilex mitis
Ficus capensis (LM)	

Shrubs from 3 to 10 ft high include:

Bowkeria triphylla	Phygelius aequalis
Calpurnia intrusa	Salix woodii
Cliffortia linearifolia	

The tree ferns, *Cyathea dregei* (Photo. 99) and *C. capensis*, occur along watercourses, the former commonly in the open, and the latter occasionally in Streambank Scrub and Streambank Forest.

Precursors and initial forest trees, from 10 to over 40 ft high, that are common to abundant with the hygrophilous trees and shrubs, include (see also section 8.5):

Burchellia bubalina	Maytenus peduncularis
Cussonia spicata	Olinia emarginata (UH)
Diospyros whyteana	Pittosporum viridiflorum
Halleria lucida	Rapanea melanophloeos
Leucosidea sericea	Rhus legatii

Common to abundant or locally dominant forest precursor shrubs, 3 to 8 ft high, are (see also section 8.5):

Artemisia afra	Erica spp. (Chapter 9)
Buchenroedera lotonoides	Hypericum revolutum (M)
	Maesa lanceolata (M)
Cliffortia nitidula	Myrsine africana
Diospyros austro-africana	

On rocky streambanks, Rock and Cliff Scrub species such as *Greyia sutherlandii*, are often frequent

Pteridium aquilinum and the tall grasses, *Cyrtobop[illegible] excavatus*, *C. validus*, *Hyparrhenia spp.* and *M[illegible] thidium capense*, are conspicuous in open str[illegible] vegetation. *M. capense* is particularly ab[illegible] marshy habitats. *Hyparrhenia spp.* (Ch[illegible] abundant on boulder beds and in open *Leucosid[illegible] sericea* Scrub (section 8.5 (D)) along streams in the High Drakensberg foothills.

As in the Coast Regions (Chapter 5), Open Streambank Tree and Scrub Communities form initial stages in the woody plant invasion of streambanks. Where fires are frequent, mesoseral grasses are maintained, but where there is some protection from fires, Open Streambank Tree and Shrub Communities develop. The Open Communities may also be fire or secondary degraded forms of closed communities.

Where complete protection from fire and disturbance occurs, closed Streambank Scrub, Streambank Scrubforest and Streambank Forest is developed. These communities are dominated by forest precursors and forest initials, and are discussed in sections 8.5 and 8.6.

8.2 Cliff, Rock Outcrop and Shallow Soil Vegetation

Cliffs, rock outcrops and shallow soils provide a variety of habitats for plants. The xerosere communities occur abundantly in the rugged foothills of the High Drakensberg, where the Cave Sandstone formation provides an almost continuous line of imposing cliffs at the upper boundary of the Highlands Region. Below the cliffs are talus and scree, scattered large sandstone blocks and boulders extending far down the steep slopes. From 500 to 1,000 ft below the Cave Sandstone, the Molteno and Beaufort Series also form small cliffs and rock outcrops. Cliff and rock outcrop habitats are less conspicuous in the remaining areas of the Uplands Regions than in the High Drakensberg foothills.

In addition to the vegetation described in this section, there are the Grass Communities of Shallow Soils (Chapters 7 and 9), *Aloe arborescens* Scrub (Chapter 5), Fynbos (Chapter 9), Forest precursors and Forest initials (section 8.5).

Development of the xerosere is related to the build-up of soil and the incidence of fire. In the initial stages, soil is limited and fire is absent. In later successional stages, soils are deeper, permitting a greater development of vegetation, whose character depends upon the extent to which it is affected by fire. Trees and shrubs occur where their seedlings get some protection from fire, and grasses where there is no protection from fire (see also Chapters 5 and 7).

(A) PIONEER ROCK AND CLIFF STAGES

Numerous plants occur on rock faces, on ledges and in crevices. The following account is limited to an indication of the nature of this complex vegetation.

Lichens are common on smooth, dry rock faces, whereas on moist faces various algae, mainly Cyanophyceae (Bews, 1917), and Bryophyta occur. In the upper Highlands Region mats of *Vellozia spp.* extend over steep faces from crevices and ledges.

Crevices and ledges contain numbers of plants ranging from small herbs, xerophytic ferns and mosses, to small shrubs and even trees. Common ferns are:

Asplenium spp.	Notholaena eckloniana
Cheilanthes spp.	Pellaea spp.
Mohria caffrorum	

Common herbs, geophytes, semi-shrubs, grasses and sedges include (UH = Upper Highlands Region):

Aristida spp.	Scilla kraussii
Carex zuluense	S. natalensis
Danthonia spp. (UH)	S. spp.
Haemanthus hirsutus	Streptocarpus spp.
Helichrysum spp.	Vellozia talbotii
Peperomia reflexa	V. viscosa
	Wahlenbergia montana

Common shrubs and trees in large cracks, on ledges and between large boulders, include:

Aloe arborescens	Greyia sutherlandii
Aster filifolius	Muraltia saxicola
Cephalanthus natalensis	Myrica serrata
Chrysanthemoides monilifera	Ochna atropurpurea
	Pavetta cooperi
Cussonia paniculata	Passerina filiformis
C. spicata	Phylica paniculata
Crassula orbiculata	Stoebe vulgaris
Erica spp.	Forest Precursors (section 8.5)
Ficus ingens	
Gnidia fastigiata	Forest Initials (section 8.5)

(B) GREYIA SUTHERLANDII CLIFF AND BOULDER SCRUB

Open scrub, dominated by twisted, thick-stemmed, deciduous shrubs or low-branching small trees, 5 to 10 ft high, of *Greyia sutherlandii* occurs frequently on cliffs, on boulder scree and on large rock outcrops in the Uplands Regions, and occasionally in the Coast Hinterland Region. These communities also occur on steep mesoclines in the Interior Valley Sub-region. Cliff and boulder associes of *G. sutherlandii* and *Cussonia spicata* and, in the High Drakensberg foothills, of *C. paniculata*, are frequent.

Greyia Scrub is an early and important stage in the development of forest, forming the foci for development of bush clumps containing numerous forest precursors. At the Gudu Forest in the Royal Natal National Park, instances can be seen where forest development on boulder scree is shading out and suppressing the original heliophilous *Greyia* Scrub. But the forest succession is usually prevented by fire and *Greyia* trees are usually stunted and scarred by recurrent burning.

(C) CUSSONIA SPP. SCRUB AND TREE VELD

As indicated in Chapter 6, section 6.4, *C. spicata* is

one of the most widely distributed trees in the Tugela Basin, occurring commonly up to about 6,500 ft altitude. In the Uplands Regions, evergreen *C. spicata* Scrub and Tree Veld, from 12 to 20 ft high, occurs on rock outcrops, on scree and on rocky hillsides, where it may be associated with the shorter, slender, glaucous leaved species, *C. paniculata*, from 5 to 10 ft high.

Cussonia spp., which in the High Drakensberg foothills are frequently associated with *Greyia sutherlandii*, resemble the latter in their successional relations, forming centres of precursor and initial forest development in the absence of fire (see (B)). The taller *C. spicata* is less easily shaded out than is *Greyia sutherlandii* and *C. paniculata* and in scrub-forest and low forest, old, thick-boled trees remain as indicators of early successional stages. *C. spicata* is also a frequent constituent of secondary forest.

(D) PAVETTA-CEPHALANTHUS BOULDER SCRUB

A low *P. cooperi-C. natalensis* Scrub, 2·5 to 5 ft high, frequently occurs amongst boulder clumps as a seral stage to *Cussonia spp.* Scrub, or to precursor and initial forest communities (section 8.5).

Pavetta-Cephalanthus Scrub occurs mainly north of the Tugela River, though occasional communities may be found in the Southern Highlands. In the moist transitional grassland faciations of the Interior Basins Region (Map 1, Chapter 7), occasional *Pavetta-Cephalanthus* Scrub is seral to Mesophytic Kloof and Rocky Hillside Scrub-forest.

(E) SCILLA NATALENSIS COMMUNITIES

Open communities of *S. natalensis*, with its slender, spicate inflorescences up to 3 ft high, are common on very steep hillsides in the foothills of the High Drakensberg and in Subalpine vegetation of the Mountain Region (Photo. 89). The large bulbs, of which more than half may be above the soil surface, resist fire on account of the surround of leaf bases. *S. natalensis* plants scattered amongst grasses, may form an initial stage in the fire deflected plant succession to grassland. But where fires are absent or infrequent, associated plants are commonly forest precursors and forest initials. Eventually these become dominant, resulting ultimately in the development of Mountain *Podocarpus* Forest or, at higher altitudes, of Subalpine scrub.

8.3 Uplands Savanna

Compared with vegetation in the Coast, Valley and Interior Basins Regions, savanna communities are of limited extent in the Uplands Regions. Indigenous *Acacia spp.*, the principal savanna tree species at lower altitudes, are rare in the Uplands Regions, and the Uplands Savanna is composed of *Protea spp.* and, less commonly, *Leucosidea sericea*. The latter community, however, is secondary (see section 8.5).

(A) PROTEA SAVANNA

Distribution and general ecology: Extensive, but discontinuous, evergreen *Protea spp.* Savanna, occurs mainly in the High Drakensberg foothills between 5,000 ft and 6,500 ft above sea level (Photos. 100, 101, and Frontispiece). Smaller communities, at from 2,000 to 8,000 ft altitude, occur on the Northern Highlands, Low and High Drakensberg, Biggarsberg, Helpmekaar Range, Southern Highlands, Qudeni Range and in the Coast Hinterland Region. The distribution of *P. multibracteata-P. rouppelliae* Savanna is shown on Map 1. It covers approximately 380 square miles, or 3·4% of the Tugela Basin.

Along the Drakensberg and at Qudeni the mean annual rainfall is over 1,100 mm. But outliers of this savanna also occur where the rainfall is as low as 850 mm. in areas subject to much mist. On the Drakensberg it occurs mainly on steep hillslopes and ridges, where plants are subject to only moderately severe frosts.

Protea Savanna soils may be either well drained deep or shallow soils. Soils are acid, leached ferrallitic types commonly derived from sedimentary formations, such as the Cave Sandstone and Beaufort Series. The soils are less commonly derived from metamorphic formations, such as the Insuzi Series, and from basic igneous rocks such as dolerite and basalt.

Protea trees and shrubs are subject to recurrent fires of the grass stratum.

Protea *Communities:*

(i) P. multibracteata *Savanna*. This is the most widely distributed and abundant *Protea* found in the Tugela Basin (Frontispiece and Photo. 101). Communities are composed of scattered, twisted, evergreen, compact trees from 5 to 10 ft high. The grass stratum is principally the *Themeda-Trachypogon* Grassland *Pt[illegible]* Faciation, described in Chapter 7. An *Aristida* [illegible] *formis* stratum occurs in Savanna of the [illegible] Hinterland Region at Kranskop, where [illegible] Hlalele, Pomeroy and Elandskraal outliers [illegible] layer is a transitional *Themeda-Trachypogon* to *Themeda-Hyparrhenia* Grassland (Chapter 7). In the Hlalele and Elandskraal outliers there is an intermingling of *Acacia*

karroo with *P. multibracteata*, the former species being the result of a secondary invasion from the drier Interior Basins Region (Chapter 6).

P. multibracteata occurs on the deeper, though nevertheless well drained, soils. Because of the denser grass cover on these soils, fires are fierce and frequent. *P. multibracteata*, with its thick bark and growth from dormant buds, endures fires more successfully than the other *Protea* species, but trees distorted by fire are very common. Communities of *P. multibracteata* have few associated fynbos species, and show fewer tendencies to fynbos development than communities of *P. rouppelliae*, *P. subvestita* and *P. dracomontana* (Chapter 9).

(ii) *P.* gaguedi *Savanna*. Communities are similar in appearance to those of *P. multibracteata*. The southernmost African distribution of *P. gaguedi* occurs in the Insuzi Valley (Beard, 1958). Here, the species occurs on stony, shallow soils of the Insuzi Series under relatively dry conditions in the ecotone between the Coast Hinterland and Valley Regions.

(iii) *P.* rouppelliae *Savanna*. Composed of uniformly round-crowned trees, 8 to 15 ft high, scattered in an open, short grass cover on shallow, stony soils (see Chapter 7, section 7.3), along ridges and emergent rock strata, especially on the Cave Sandstone formation of the Drakensberg. The species is second to *P. multibracteata* in frequency of occurrence, but the communities are much more limited in extent, occurring principally on the Drakensberg, where they extend to higher altitudes, 7,000 ft to 7,500 ft, than do those of *P. multibracteata*. Outliers occur far to the east on the summits of Qudeni and Mount Gilboa.

Although *P. multibracteata* and *P. rouppelliae* Savannas occur together, close examination reveals a segregation of the communities on deeper and shallow soils respectively. On the shallow soil habitat, with its short, open grass cover, *Erica spp.* and other Fynbos species are found occasionally to frequently with *P. rouppelliae*.

(iv) P. dracomontana *Shrub Savanna* occurs at between 6,000 ft and 8,000 ft altitude on shallow soils overlying the lower basalt and Cave Sandstone slopes of the High Drakensberg (Photo. 100). Communities are composed of scattered shrubs, from 1·5 to 5 ft high. On rocky areas protected from fires, *P. dracomontana* attains its greatest height and Fynbos species, including *Encephalartos ghellinckii*, are frequent to abundant (Chapter 9). Evidence has been found that *P. dracomontana* occurs more abundantly on the autumn burnt firebreaks of the Forestry Department than in the surrounding grassland burnt in spring.

(v) P. simplex *Shrub Savanna*. Dwarf *P. simplex* shrubs, from 6 ins to 2 ft high, with large underground rootstocks, form communities in an association with *P. multibracteata* on the Drakensberg and in the Qudeni area. However, *P. simplex* usually occurs on stonier and shallower soils than does *P. multibracteata*.

Discussion: Protea Savanna shows few tendencies to scrub formation, and woodland or scrub is rare. Instances occur of spread of *P. multibracteata* along old footpaths, where numerous *Protea* seeds have collected, and in a heavily populated area of the Upper Tugela Bantu Location. In these instances, reductions in grass vigour and of fire intensity and frequency have resulted in a fairly dense scrub development analagous to that shown by many *Acacia* species. Such instances are rare, however, and are greatly exceeded by the overall evidence of a high mortality amongst *Protea* individuals. As a whole, *Protea* Savanna is being replaced by pure grassland, especially in the eastern outliers.

The main reason for the decrease of *Protea* Savanna is the damaging effects of veld fires. Beard (1958) has suggested that *Protea spp.* are relatively fire-resistant, but there is a limit to their fire tolerance. Examination of dead or dying *Protea* trees often reveals fire as a direct cause of death. As in the case of forest vegetation, the tendency is for replacement of *Protea* Savanna by fire-tolerant grassland. This may be ascribed to a marked increase in veld burning as a result of the increased population and settlement of the Tugela Basin in the last hundred years. If *Protea* Savanna is to be maintained veld fires must be controlled.

Another reason for the decline of *Protea* vegetation may be seen in the light of their ancient phytogeographical relationships. As expressed by Beard (1958):

'There is little doubt from the relics that occur in protected situations that this open *Protea* woodland as we now see it is a remnant, decimated by fire, of a Macchia floristically and physiognomically similar to the Cape fynbos.'

8.4 Secondary Scrub

Because of poor communications and the 'sour veld' character of the Moist Grasslands, most Uplands Vegetation has been subject to less utilization and disturbance than vegetation in the Interior Basins and Valley Regions (Chapter 4). The increasing development of the Uplands Regions is, however, causing an increase in secondary vegetation, especially of introduced or exotic species.

Indigenous species which form secondary communities are mostly constituents of the undeflected primary forest succession, for example, *Leucosidea sericea*. Their secondary encroachment follows upon disturbance of the grassland and the reduction in intensity of fires and grass competition. Secondary communities thus appear as a form of acceleration of the primary succession to the climatic climax forest (cf. Phillips, 1934), but continued grazing, browsing, trampling and erosion may cause their destruction.

Introduced species are usually more aggressive in forming a secondary vegetation than are the indigenous species, but they also enter the composition of communities seral to forest. For example, *Rubus cuneifolius* and *Acacia mearnsii* are occasional to locally frequent constituents of forest margin and precursor scrub.

(A) SECONDARY SCRUB COMMUNITIES OF INDIGENOUS SPECIES

The principal indigenous species forming secondary scrub in the Uplands Regions are:

Aster filifolius	Cliffortia repens
Athanasia acerosa	Leucosidea sericea

Aster filifolius occurs as an occasional species in the early succession on boulder beds and rocky areas in the upper Highlands Region and Subalpine vegetation (Photo. 96). On severely eroded areas, with a short, open grass cover in the Uplands and Interior Basins Regions, however, open, secondary low shrub communities, 1 to 3 ft high, are found. Secondary communities occur also in Semi-deciduous Bush in the lower Mooi River Valley (Chapter 6).

Athanasia acerosa appears as an occasional to frequent species in forest margin and precursor scrub, and in boulder bed scrub along rivers and streams. Secondary communities, 2·5 to 4 ft high, appear on heavily grazed, short grasslands, chiefly in the Midlands Mist Belt, South-eastern and Eastern Highlands (Photo. 94). Communities are commonly on grasslands grazed short by sheep.

Under primary conditions, *Cliffortia repens* is an occasional to frequent constituent of streambank, rock outcrop and fynbos communities seral to forest. Secondary *C. repens* scrub, 1 to 4 ft high, occurs on severely overgrazed grasslands in the Qudeni area, and locally in the Giants Castle-Highmoor area.

Secondary *Leucosidea sericea* Scrub is described in section 8.5.

(B) SECONDARY COMMUNITIES OF INTRODUCED SPECIES

A number of introduced trees and shrubs form secondary communities. Disturbance, such as soil erosion and heavy grazing, greatly favours these species. The most important are:

Acacia mearnsii	Ulex europeaus
A. dealbata	Sarothamnus scoparius
Rubus cuneifolius	

U. europeaus and *S. scoparius*, Gorse and Broom respectively, are at present confined mainly to the Highmoor area at 6,500 ft on the Little Berg, where they form a dense scrub on disturbed areas (Photo. 97). Gorse could prove a serious problem in the Highlands Region, unless its spread is checked now.

Dense, thorny, impenetrable thickets, 6 ft or more in height, of the American Bramble, *Rubus cuneifolius*, occur frequently in grassland and on disturbed areas in the Southern and South-western Highlands. The species is one of the most serious weeds in the Uplands Regions.

Tree communities, over 15 to 20 ft high, of the Silver Wattle, *Acacia dealbata*, are spreading widely in the Southern, South-western and Western Highlands, and western Interior Basins Region. Extensive communities are found along the Bushmans River above Estcourt. The Black Wattle, *Acacia mearnsii*, is spreading in the Midland Mist Belt and Coast Hinterland Regions. Both species encroach along rivers, along dongas and on eroded areas, or wherever there is a poor grass cover.

8.5 Forest Precursors and Forest Initials

As defined for Coast Vegetation in Chapter 5, section 5.5, communities and species successionally closely related to forest are termed forest precursors and forest initials. They include a number of clearly defined communities, as well as a number of heterogeneous scrub and scrub-forest communities. Precursor and initial forest species appear early in hydroseres and xeroseres, though certain species may occur chiefly in one or the other.

The following forest precursor communities are discussed in previous chapters: Bracken Veld (*Pteridium aquilinum*) and *Sticherus* Consocies in Chapter 5, section 5.5; *Cymbopogon-Miscanthidium* and *Hyparrhenia* Tall Grass Communities in Chapter 7, sections 7.3 and 7.4; and Fynbos in Chapter 9, section 9.1.5.

(A) CLIFFORTIA NITIDULA SHORT WOODLAND

A short, dense, but not impenetrable woodland domi-

nated by much branched, straggly *C. nitidula* trees, up to 18 ft high, averaging approximately 12 ft high, with boles up to 6 ins diameter at breast height, has been recorded only once, at 5,600 ft on Madhlosi Mountain near Qudeni (Photo. 106). Associated species are forest precursors and initials (see (E), (F)), suggesting a seral relationship to Mountain *Podocarpus* Forest.

C. nitidula Woodland is of particular interest, since the species may be found as a frequent to abundant small shrub constituent, up to 6 ft high, of periodically burnt shrub and fynbos communities (Photo. 105). The Woodland apparently represents the potential community development in the absence of burning. In view of the general replacement of forests and seral forest communities by grasslands, it is probable that such communities were at one time more widespread. In addition, the *C. nitidula* community represents a physiognomically and structurally uncommon (for the Tugela Basin) sclerophyllous or fynbos, montane woodland type.

(B) HYPERICUM REVOLUTUM SCRUB

This dense, evergreen scrub, 5 to 10 ft high, occurs in the Qudeni area (Photo. 103). It occurs on forest margins and along streambanks, forming an important seral community to Mist Belt Mixed *Podocarpus* Forest. Scrub-forest forms, with initial forest trees, are often found.

(C) CASSINOPSIS ILICIFOLIA SCRUB

Dense, scarcely penetrable, evergreen, spinescent *C. ilicifolia* Scrub or Thicket, 6 to 12 ft high, occurs occasionally in the Uplands and Coast Hinterland Regions. Primary communities seral to forest occur on scree and in kloofs. Secondary communities frequently develop where forest trees are felled.

(D) BUDDLEIA-LEUCOSIDEA SCRUB AND WOODLAND

Heliophilous, evergreen scrub and woodland of *Buddleia salviifolia* and *Leucosidea sericea* occur on streambanks, on rocky soils, in kloofs and on forest margins in the Uplands Regions, and up to nearly 8,000 ft in the Subalpine Belt of the Mountain Region (Photos. 98, 116). Communities of *B. salviifolia* occur occasionally in the Coast Hinterland.

B. salviifolia and *L. sericea* may occur together in mesic habitats. *B. salviifolia* Scrub is found on drier, *L. sericea* Scrub in moister habitats. The latter species forms more extensive communities than does *B. salviifolia*.

Considerable variations are found in the structure and physiognomy of the *Buddleia-Leucosidea* communities. They may be composed of shrubs, from 5 to 12 ft high, forming an open or closed scrub, or of trees, up to 30 ft high, with boles over 10 ins in diameter, forming a dense woodland or scrub-forest. A lower shrub and small tree stratum, from 3 to 6 ft high, is poorly developed, except in scrub-forest, where it is composed mainly of forest precursors (see (E)). The field layer varies from sparse in dense scrub, to well developed in woodland and in scrub-forest where there are many herbs (section 8.6).

Buddleia and *Leucosidea* Scrub and Woodland communities are important precursors to the Uplands Forests. Both species are tolerant of occasional fires, coppicing freely after burning. Communities subject to recurrent fires are either maintained as an open scrub or become replaced by grassland, depending on the frequency and intensity of fires. In the absence of burning, conditions become favourable for the growth and development of forest initials and the lower forest strata. Ultimately, the initial forest trees assume dominance, shading out the light demanding *B. salviifolia* and *L. sericea* precursors. In severe frost hollows of the Highlands Region and in the lower Subalpine Belt below 8,000 ft, *L. sericea* is an important component of the climax scrub-forest or woodland vegetation (see Chapter 9, section 9.1.4).

Buddleia and *Leucosidea* also form secondary communities (Photo. 93). Secondary *Buddleia* communities are limited to eroding areas where the grass cover is poor. Secondary *Leucosidea* communities are more widespread, and in sheep grazed short grass areas above Utrecht and in the Charlestown areas of the Northern Highlands cover many hundreds of acres. In the Middlerest-Umhlumba area, secondary *Leucosidea* extends downwards along streambanks and eroded areas, meeting and intermingling with invading *Acacia karroo* Thorn Veld.

(E) FOREST MARGIN AND PRECURSOR SCRUB

These include a number of heterogeneous communities composed of heliophilous small trees, shrubs and semi-shrubs. They occur on forest margins, on rock outcrops and along streambanks (see also Chapter 5, section 5.5).

Only very locally, for example in the Pomeroy and Umhlumba areas, are *Acacia sieberiana* and *A. karroo* ever found intermingling with Uplands Forest precursor communities.

Uplands precursor communities form a scrub, from

4 to 20 ft high (Photos. 92, 102, 107, 108).

The principal precursor trees are shrubby and relatively short, from 8 to 20 ft high, and mainly evergreen. Species of earlier scral stages are (L = Lower; M = Midland Mist Belt Region; H = Highlands Region; U = Upper):

Anastrabe integrerrima (M)	Greyia sutherlandii
Buddleia salviifolia	Hippobromus pauciflorus
Canthium inerme (M)	Leucosidea sericea
C. mundtianum	Maytenus cymosus (forma)
Clerodendrum glabrum (LM	Pachystigma macrocalyx (M)
Cussonia paniculata	Phylica paniculata
C. spicata	Rhus fastigiata
Erythrina latissima (M)	R. lucida
Euclea crispa	R. pyroides
	Smodingium argutum (LM)

Trees tolerant of light shade and occurring in later seral stages are:

Alberta magna (M)	Englerodaphne pilosa
Allophylus melanocarpus	Cunonia capensis
Burchellia bubalina	Fagara capensis (LM)
Cassine euclaeformis (M)	Heteromorpha trifoliata
Clausena anisata	Solanum mauritianum (M) (introduced)

On streambanks, *Bowkeria triphylla* and *B. verticillata* are typical Streambank Forest precursors (see also section 8.1 (A)).

Prominent in the scrub are shrubs from 3 to 10 ft high. Species include:

Andrachne ovalis	Leonotis leonurus
Anthospermum hispidulum	Maesa lanceolata (LM)
	Myrsine africana
Artemisia afra	Ochna atropurpurea
Asparagus spp.	Osyris compressa
Athrixia phylicoides	Pavetta lanceolata (LM)
Calpurnia intrusa (H)	Pentzia pinnatifida
C. subdecandra	Philippa evansii
Cassinopsis ilicifolia	Polygala virgata
Cliffortia linearifolia	Psoralea caffra
C. nitidula	Rhamnus prinoides
C. repens	Rhus dentata var. grandifolia
Clutia spp.	
Dombeya pulchella	R. tomentosa
Ekebergia pterophylla (M)	Rubus cuneifolius (introduced)
Erica spp.	
Euphorbia epicyparyssias	R. ludwigii
Grewia occidentalis	Selago natalensis
Hemizygia stenophylla	Stoebe vulgaris
Hypericum revolutum (M)	Widdringtonia dracomontana (UH)
Indigofera cuneifolia	

Bracken, *Pteridium aquilinum*, is common in forest margin and precursor scrub. The tree fern, *Cyathea dregei*, occurs in Streambank Scrub.

Tall grasses are common to abundant:

Cymbopogon excavatus	Hyparrhenia cymbaria (M)
C. validus	H. hirta
Hyparrhenia aucta	Miscanthidium capense

The Berg Bamboo, *Arundinaria tesselata*, occurs in protected situations on forest margins at the upper limits of forest in the Drakensberg.

Tall herbs, especially on moist soils, may be frequent to abundant, for example:

Anemone fanninii	Plectranthus spp.
Buchenroedera lotonoides	Senecio spp.
	Tysonia africana
Carex zuluensis	Vernonia spp.
Helichrysum spp.	and many other species
Galtonia candicans	

Parasitic *Cassytha spp.* are occasional to frequent in forest margin and precursor scrub.

Climbers are generally common, especially herbaceous and semi-woody species. They include:

Behnia reticulata (M, LH)	Dioscorea dregeana
Buddleia auriculata	D. sylvatica
B. pulchella	Melothria cordata
Canthium gueinzii (M)	Rhoicissus tridentata
Cassinopsis ilicifolia	R. rhomboideus
Chilianthus dysophyllus	R. revoilii
Cissampelos torulosa	Riocreuxia torulosa
Clematis brachiata	Rhynchosia caribaea
Coccinia palmata	Scutia myrtina
Dalbergia obovata	Senecio macroglossus
	S. tamoides

Further development of Forest Margin and Precursor Scrub is to a *Leucosidea sericea* or *Buddleia salviifolia* community, or directly to a scrub-forest or short forest in which the initial forest species become dominant (F).

In addition to their important rôle in the primary succession, forest precursor species are also important in secondary successions arising from forest destruction.

(F) FOREST INITIALS, SCRUB-FOREST, SUBCLIMAX AND TRANSITIONAL FOREST

As defined and described in Chapter 5, section 5.5, forest initials are the first forest species to appear in the plant succession. Initial forest trees are dominant in scrub-forest, and later in a sub-climax community which resembles climax forest (section 8.6).

The principal Uplands Forest Tree Initials, over 15 ft high, are (UH = Upper Highlands Region):

Apodytes dimidiata	Maytenus acuminatus
Calodendrum capense	Ochna natalitia
Celtis africana	Olinia emarginata (UH)
Cryptocarya woodii	Pittosporum viridiflorum
Dais cotinifolia	Podocarpus latifolius
Diospyros whyteana	Rapanea melanophloeos
Ekebergia capensis	Rhus legatii
Combretum kraussii (M)	Scolopia mundii
Hallcria lucida	Trimeria grandifolia
Kiggelaria africana	

On streambanks the principal species are *Ilex* [illegible] and *Maytenus peduncularis*.

Initial forest shrubs, up to 8 ft high, inc[illegible]

Canthium ciliatum	Dovyalis lucida
C. spinosum	Maytenus mossambicensis
Carissa bispinosa	M. undatus

Typical field layer forest initials have not been determined, but many of the species listed for the Uplands *Podocarpus* Forests are found in scrub-forest and in sub-climax Forest.

Initial forest climbers are *Cnestis natalensis* and *Popowia caffra* of the Midland Mist Belt Region. But falling trees, or a lighter canopy due to shallow soils, provide conditions suitable for many climbers classified as forest precursors. Important are the woody climbers, *Dalbergia obovata* (Midland Mist Belt Region), *Scutia myrtina* and *Rhoicissus spp.*, all of which reach the upper canopy and persist in the climax forest.

Subclimax Forest is from 20 to 30 ft high in the Highlands Region, and from 30 to 50 ft high in the Midland Mist Belt Region. It has similar structural characters to climax forest described in section 8.6, and is composed of the more mesophytic forest precursors (see (E)), forest initials (dominant), and a few of the climax forest species.

Transitional Short Mountain Forest is found in the transition from Highlands to Mountain Regions. It is usually less than 40 ft high, with dominance of either *Podocarpus latifolius* or of *Olinia emarginata*, the latter extending to higher altitudes. Lower tree and shrub strata are sparsely developed, but there is usually a continuous field layer of herbaceous plants, such as *Cyperus zuluensis*, less than 2 ft high (see section 8.6 (B)).

Transitional Short Mountain Forest is usually found along streambanks and in sheltered kloofs, on and above the Cave Sandstone. It closely resembles late seral stages in the development of Mountain Forest at lower altitudes.

Northern Highlands Dry Short Forest. Although temperatures along the Northern Highlands are similar to those of the Southern Highlands, the rainfall and mist is generally less than in the remaining areas of the Highlands Region (Chapter 2). In the few samples studied, the climatic climax vegetation was a Dry Short Forest, from 15 to 30 ft high, with forest precursors (see (E)), principally *Leucosidea sericea*, and forest initials (see preceding) as the chief components (Photo. 116). Precursor and initial forest shrubs, from 3 to 10 ft high, are abundant, and the Dry Short Forest is dense and scrubby. Disturbance in these forests is marked.

8.6 Uplands Podocarpus Forests

Evergreen *Podocarpus* Forests form the climatic climax vegetation of the Midland Mist Belt and Highlands Regions. The forests comprise:

(i) Mist Belt Mixed *Podocarpus* Forest, from 3,500 ft to 4,500 ft above sea level. These form the tallest forests in Natal and Zululand.

(ii) Mountain *Podocarpus* Forest, from 4,500 ft to 6,500 ft in the Highlands Region. They are shorter and simpler in structure, and are floristically poorer than Mist Belt Forest.

The Uplands Forests are limited in extent, and altogether are estimated to cover approximately 20 square miles, or 0·2% of the Tugela Basin (Map 1).

(A) MIST BELT MIXED PODOCARPUS FOREST

Distribution and general ecology: Mist Belt Forest includes the extensive Qudeni Forest (Photo. 109) and its surrounding relic patches, together with a few small, mutilated forests in the Kranskop-Greytown area (Map 1).

The following account of Mist Belt Forest is based on the Qudeni Forest. All other Mist Belt Forest patches encountered represent similar but depauperate forms of this forest. The lowest Semi-coast section of the Qudeni Forest, below roughly 3,500 ft, is discussed in Chapter 5, section 5.6.

The Qudeni Forest Reserve under the control of the Department of Forestry is 5,800 acres in extent, the greater part being covered by indigenous forest. The forest occurs on steep south facing slopes, from 3,500 ft to 5,000 ft altitude, on a number of sloping terraces separated by krantzes or steep ground.

Temperatures are equable with low maxima and high minima. Moderately severe frosts occur on level ground, but probably not on the steep slopes on which the forest is situated. Snow has been recorded periodically at Qudeni (see Chapter 2). Mean annual rainfall ranges from 1,000 mm. in the lower parts of the forest to over 1,500 mm. in the upper parts of the forest. Mists are abundant and important. Storms are common in summer, and wind-thrown and lightning blasted trees may be seen in the forest. Hail storms are frequent.

Soils are highly leached ferrallitic types derived from dolerite and the Middle Ecca Series. They vary from over 5 ft deep, where the tallest forest is found, to shallow skeletal soils, less than 1 ft deep, where the forest is usually short. Forest is also frequently found on steep scree slopes.

History of utilization: The Qudeni Forest is one of the traditional forests of the Zulu people, and was frequently used as a refuge during the unsettled Early Bantu Period (Chapter 4). Following the arrival of European settlers during the nineteenth century, con-

siderable use was made of the valuable timber in the Forest.

The Report of the Zululand Boundary Commission of 1880 noted that some of the best wood in Zululand was to be found in the Qudeni Forest, and in 1891, the Resident Commissioner of Zululand, Colonel Cardew (King, 1941), described it as 'the finest in Zululand'. Colonel Cardew deplored the destruction that was taking place through the conversion of forest land into mealie gardens. He noted that exploitation of the Zululand forests began at Qudeni, and that cutting was commenced by sawyers, who apparently obtained permission from the paramount chief long before the annexation of Zululand in 1887. According to Lister (1902), the Qudeni Forest was 'said to have been heavily worked, in the early days, while under the jurisdiction of John Dunn'.

A steam saw mill was started about 1897 by the Qudeni Saw Mills Co., functioning until 1918, when the machinery and buildings were dismantled (King, 1941).

Though Colonel Cardew described the Qudeni Forest as resembling the high timber forests of Natal, containing an abundance of both Upright (*Podocarpus latifolius*) and Outeniqua (*P. falcatus*) Yellowwoods, Barton (King, 1941), who visited the forest in 1914, described the western portion as 'a black ironwood forest' (see following) and made no mention of Yellowwoods in this section. In the eastern section he recorded occasional large *P. latifolius* and isolated *P. falcatus*.

Today, *P. latifolius* occurs as an occasional to common species, rare in the most heavily worked sections of the forest, and common in the forest areas difficult of access. There is abundant regeneration of *P. latifolius*, but *P. falcatus* is seldom found. General dominants are the ironwoods, *Olea capensis* subsp. *macrocarpa* and *Linociera peglerae* (see following).

Structure and composition: Forest precursors, found occasionally to locally abundantly in forest, are generally not included in the following lists of species.

The tallest trees, emergent from the continuous upper canopy, are from 70 to 100 ft high. The average diameter at breast height is from 18 to 36 in, but specimens with a diameter between 3 and 6 ft may also be found.

Frequent to abundant emergent species are:

Olea capensis subsp. macrocarpa	Ptaeroxylon obliquum
Combretum kraussii	Podocarpus latifolius
Rapanea melanophloeos	Pygeum africanum
Celtis africana	Homalium dentatum
Calodendrum capense	Fagara davyi
Kiggelaria africana	Cussonia chartacea

Ilex mitis is frequent along streambanks and in other moist areas.

Occasional to frequent emergent species are:

Podocarpus falcatus	Faurea macnaughtonii
Cryptocarya latifolia	Ficus natalensis

No large trees of *Ocotea bullata* have been found, the species being ruthlessly barked and cut out by Bantu, for whom the tree has a considerable value as a medicine.

Species, that do not appear to attain the same height as in Semi-coast Forest, but are exceeded by the generally taller trees of Mist Belt Forest, are:

Brachylaena transvaalense	Syzygium gerrardii
Nuxia floribunda	Strychnos henningsii

The rather low relative abundance of *Podocarpus latifolius* is almost certainly due to the species having been cut out in the past. If *Podocarpus falcatus* was as abundant in the nineteenth century as suggested by Colonel Cardew (cited King, 1941), the species must have been cut almost to the point of extinction, *P. falcatus* playing a minor rôle in the present composition of the forest. *Ptaeroxylon obliquum*, Sneezewood, was also heavily felled for fencing poles.

Pygeum africanum and *Homalium dentatum* form local consociations, the former on steep scree.

Below the emergent trees is the continuous upper canopy. From 50 to 70 ft high, the canopy is tallest on flat and gently sloping areas with deep soils. Frequent to abundant trees, in addition to the emergents listed previously, are:

Linociera peglerae	Seemannaralia gerrardii
Xymalos monospora	Rhus legatii
Maytenus peduncularis	Pterocelastrus galpinii
Halleria lucida	Curtisia dentata
Scolopia mundtii	Cryptocarya woodii
S. zeyheri	Ekebergia capensis
Apodytes dimidiata	

Occasional to frequent upper canopy species include:

Pleurostylia capensis	Clerodendrum glabrum
Dais cotinifolia	Rawsonia lucida

Linociera peglerae, the chief upper canopy species, does not attain the height of the similar, but emergent *Olea capensis*. *Xymalos monospora* is a locally dominant upper canopy species.

In the discontinuous subordinate tree layer, 15 to 40 ft high, trees are generally less than 12 ins in diameter at breast height, usually from 5 to 10 ins in taller trees, and less than 6 ins for smaller individuals. Frequent to abundant species of the upper, 25 to 40 ft, portion of the stratum are:

Cassine papillosa	Ochna arborea
Burchellia bubalina	Maytenus acuminatus
Diospyros whyteana	Eugenia zeyheri

Bowkeria verticillata is common on streambanks.

Occasional to frequent upper subordinate tree layer species include:

Rothmannia capensis	Cassipourea gerrardii
Ochna holstii	Cassinopsis tinifolia
O. natalitia	Allophylus dregeanus

The absence of *Cassipourea verticillata* and *Bequaertiodendron natalense* from this stratum is one of the features distinguishing Mist Belt from Semi-coast Forest (Chapter 5).

The principal species of the lower, 15 to 25 ft high portion of the subordinate tree stratum are:

Peddiea africana	Bersama tysoniana
Trimeria grandifolia	Rinorea natalensis
Grumilea capensis	Gardenia neuberia
Cassine kraussiana	Rothmannia globosa
C. euclaeformis	

The last three species in the right column have a lower frequency abundance than in the Semi-coast Nkandla Forest.

In the Qudeni Forest there are several shrub and small tree species that occur as trees 30 ft high, with diameters between 5 and 12 ins at breast height. Such species are:

Calpurnia subdecandra	Dovyalis lucida
Canthium obovatum	Tricalysia capensis

Shrubs and small trees forming a discontinuous stratum, from 4 to 10 ft high, are:

Carissa bispinosa	Duvernoia adhatodioides
Maytenus mossambicensis	Indigofera natalensis
Cassinopsis ilicifolia	Dovyalis rhamnoides
Tricalysia capensis	D. zeyheri
Pavetta natalensis	Desmodium repandum
Dovyalis lucida	Pavetta tristis
Canthium ciliatum	Excoecaria simii
Maytenus undatus	Micrococca capensis
Mackaya bella	Piper capense
	Canthium obovatum

The coast species, *Oxyanthus gerrardii*, is rare.

The herbaceous field layer, from 0·5 to 3 ft high, varies from absent, to sparse, to luxuriant in moist areas and where the upper canopy is open. Species include:

Begonia sutherlandii	Oplismenus hirtellus
Brachypodium flexum	Panicum aequinerve
Carex zuluensis	Plectranthus spp.
Clivia miniata	Setaria chevalieri
Dietes butcheriana	Stipa dregeana
Haemanthus katherinae	Streptocarpus spp.
Hypoestes verticillaris	Acanthaceae spp.
Impatiens duthieae	

Ground layer plants, less than 0·5 ft high, occur mainly in moister parts along streams, on rocks and around the bases of trees. Many species are also epiphytic on tree trunks. Plants include:

Selaginella kraussiana	Peperomia reflexa
Streptocarpus spp.	Bryophyta
Lycopodium spp.	Small Ferns

Epiphytes are abundant on the lower trunks of trees and, including *Usnea sp.*, are also abundant on the upper branches of the canopy and emergent trees. Plants include:

Dermatobotrys saundersii	Bryophyta
Asplenium spp.	Lycopodium spp.
Polypodium lineare	Selaginella kraussiana
P. ecklonii	Usnea sp.
Other ferns	Lichens

Occasional Orchids on the upper branches of trees

Seemannaralia gerrardii and the Strangler Fig, *Ficus natalensis*, may be epiphytic in the early stages of their growth.

Parasites are represented occasionally by *Loranthus spp.*, but are less common than in Coast Forests.

Climbers are less evident than in Coast Forests. Heavy, woody, upper canopy species, that may drag down old, rotten and insecurely rooted trees, are:

Dalbergia obovata	Canthium gueinzii
Scutia myrtina	Buddleia auriculata
Secamone alpinii	B. pulchella
Rhoicissus rhomboidea	Chilianthus dysophyllus
R. revoilii	Cassinopsis ilicifolia
R. tridentata	Strophanthus speciosus
Cassine tetragona	Cnestis natalensis
Clematis brachiata	Popowia caffra
	Quisqualis parviflora

Herbaceous and semi-woody climbers, occurring mainly under the greater light intensity of a broken canopy, include:

Behnia reticulata	Potamophila prehensilis
Senecio macroglossus	Dioscorea spp.
S. tamoides	Tylophora flanaganii

Most of the climbers listed have been classified as forest precursors in section 8.5. The woody climbers, *Scutia myrtina* and *Dalbergia obovata*, attain diameters of over one foot. Climbers become rank when a break in the forest canopy occurs, and some persist for long periods, reaching the upper canopy with the new growth of trees. Conditions thus continually occur within the forest for the growth and development of these forest precursor climbers and the more shade tolerant tree and shrub forest precursors, such as *Clausena anisata* and *Heteromorpha trifoliata*.

Special physiognomic and structural features: Semi-deciduous and deciduous species, cauliflorous and spinescent species, plank and spur buttressing species are the same as those listed for Semi-coast Forest, excluding the coast species not occurring in the Midland Mist Belt Region (see Chapter 5, section 5.6). Deciduousness of trees in Mist Belt Forest is more marked than in the Coast Forests, but the majority of the species are evergreen.

Discussion: The Mist Belt Mixed *Podocarpus* Forest is the climatic climax vegetation of the Midland Mist Belt Region at altitudes between 3,500 ft and 4,500 ft (up to nearly 5,000 ft at Qudeni). The misty climate, with its high precipitation and equable temperatures, provides conditions favourable for the development of the tallest forests in Natal. Historical data confirm field evidence that Mist Belt Forest was formerly more extensive than at present, and that fire and man have been responsible for the replacement of forest by Mist Belt *Themeda* Grassland and by Secondary *Aristida junciformis* Grassland.

As discussed in Chapter 5, section 5.6, Mist Belt Mixed *Podocarpus* Forest represents one of a series of three montane type forests found with increasing distance from the sea at between 1,500 ft and 6,500 ft altitude. It is distinguished from Semi-coast Forest at lower altitudes chiefly by its less tropical composition and taller character. Mountain *Podocarpus* Forest at higher altitudes is physiognomically and structurally reduced and floristically depauperate in comparison with Mist Belt Mixed *Podocarpus* Forest.

The Qudeni Forest, upon which the forest description here is largely based, is almost at the northernmost limit of the Midland Mist Belt Region of Natal (described in Chapters 1 and 2 for the Tugela Basin) and similar to the Mist Belt Ngongoni Veld of Acocks (1953). Northwards, the forests at a similar distance inland from the coast are more tropical than those of the Midland Mist Belt Region, for example the Ngomi Forest in Northern Natal. The northern forests resemble, to some extent, the Semi-coast Forest of the Coast Hinterland Region of the Tugela Basin, and are referred to by Acocks (1953) as Inland Tropical Forest types (North-eastern Mountain Sourveld).

South of the Tugela River, Mist Belt Mixed *Podocarpus* Forests of the Midland Mist Belt Region are extensive along the Karkloof Range (Rycroft, 1943), extending south to the Natal border.

(B) MOUNTAIN PODOCARPUS FOREST

Distribution and general ecology: Apart from the Northern Highlands (section 8.5 (F)), Mountain Forest is distributed throughout the Highlands Region at between 4,500 ft and 6,500 ft altitude (Photos. 110–115). It occurs in small patches of from less than one acre to over ten acres in extent, with occasional large stands of several hundred acres, such as the Ndema (Cathkin Park), Hlatikulu and Normandien Forests. The approximate distribution of the forests is shown on Map 1, the size of the forests having been exaggerated in order to facilitate reproduction on the map.

Mountain Forest occurs on steep slopes, commonly on south aspects, in kloofs and along streambanks in the rugged areas of the Drakensberg, few stands occurring on the rather even topography below the Drakensberg (see Map 1).

Temperatures are considerably lower and more severe than in Mist Belt Mixed *Podocarpus* Forest. Moderately severe frosts occur even on steeply sloping ground. On many of the plains and valleys of the Highlands Region, frequent severe frosts are likely to prevent the development of forest. At altitudes over 6,500 ft montane temperature conditions appear to be the chief factor limiting forest development (see Transitional Forests, section 8.5 (F) and Chapter 9, section 9.1.4). Temperatures are higher on the Eastern Highlands and at exceptionally low altitudes in the Drakensberg foothills such as at Cathkin Park, forests in these areas showing transitional features to Mist Belt Forest (Chapter 2). The mean annual rainfall is over 800 mm., with mists less frequent and the winter drier than in the Midland Mist Belt Region (see Chapter 2).

Soils are acid, leached ferrallitic types (Chapter 3). Forest frequently occurs on scree, where it is often mature and well developed. Only a close examination of the substrate underlying the thick layer of organic litter may reveal the presence of large blocks of scree. Mature forests may thus be found on some of the most recent land surfaces, on habitats where forest developmental stages would have enjoyed protection from fires.

History of utilization: Present day Mountain Forests occur in European farm areas, Bantu Locations, Game Reserves, National Parks and Government Forest Reserves. In Game Reserves, Parks and Forest Reserves, the forests are protected, but protection only dates from 1903 at the earliest, and in some cases only from 1941 and 1955. The forests are frequently not protected against veld fires. Forests on Bantu lands are not protected against utilization and fire, and also not on European farms, with a few exceptions.

In the Report of the Commission of 1880 to enquire into the extent and condition of forest lands in the Natal Colony (excluding Zululand), great concern was expressed about the destruction of forests (see also Chapter 4).

The Commission recorded that in the Upper Tugela division, forests on the Natal slopes of the Low Drakensberg were used to supply—illegally—the timber requirements of settlers in Harrismith and the adjoining treeless

areas of the Orange Free State. In the Newcastle area farmers were reported to be exploiting the natural forests for poles. Veld fires were stated to be making considerable inroads, and occasionally farmers started fires to drive game out of the forests. It was also noted that much destruction of the forests was caused by large uncontrolled fires during drought years, such as in the preceding year, 1878.

In 1889, the report of Fourcade on the Natal forests confirmed the findings of the earlier 1880 Commission (see Chapter 4).

Structure and composition: Because climatic conditions in the Highlands Region are more severe than in the Midland Mist Belt Region (Chapter 2), Mountain Forest is physiognomically and structurally reduced, and floristically depauperate in comparison with the Mist Belt Forest. Mountain Forests are thus shorter, with fewer species and with forest initials dominant or co-dominant. The generally small size of the forests means a high ratio of margin to area, and a correspondingly large 'edge effect'. Thus only towards the centres of larger forests are climax forest conditions, and climax forest species, commonly found in addition to the dominant forest initials.

Some of the more shade tolerant forest precursors appearing in forest as a result of a break in the canopy have been omitted from the following lists (see section 8.5).

Frequent to abundant emergents, 50 to 70 ft high, and species of the upper canopy, from 40 to 55 ft high, are (U = Upper Highlands Region; L = Lower Highlands Region):

Podocarpus latifolius	Kiggelaria africana
Halleria lucida	Cryptocarya woodii
Rapanea melanophloeos	Olinia emarginata (U)
Maytenus peduncularis	Celtis africana
Scolopia mundtii	Calodendrum capense

Ilex mitis is a dominant along streambanks.

Occasional to frequent or locally dominant emergent and upper canopy species are:

Apodytes dimidiata	Pittosporum viridiflorum
Clerodendrum glabrum	Pleurostylia capensis
Curtisia dentata	Podocarpus falcatus
Cussonia chartacea	Ptaeroxylon obliquum
Dais cotinifolia	Pterocelastrus galpinii
Ekebergia capensis	P. sp. (DE318, Killick 1730)
Fagara davyi	Pygeum africanum
Linociera foveolata	Vepris undulata

Ocotea bullata, highly prized by the Bantu as a medicine, is rare.

Except where it has been completely cut out of the forests, *Podocarpus latifolius* is the dominant species. In only one instance, at the Ndema Forest at Cathkin Park, has the related yellowwood species, *P. falcatus*, been observed dominant.

The dominant tree of the subordinate stratum, from 15 to 30 ft high, is *Diospyros whyteana*. Other species are:

Trimeria grandifolia	Maytenus acuminatus
Burchellia bubalina	M. cymosus
Allophylus melanocarpus	Clausena anisata

Species of the discontinuous shrub layer, 3 to 8 ft high, are:

Carissa bispinosa	Andrachne ovalis
Canthium ciliatum	Dovyalis lucida
C. spinosum	D. zeyheri
Myrsine africana	Ochna atropurpurea
Cassinopsis ilicifolia	Calpurnia subdecandra
Maytenus mossambicensis	Pavetta lanceolata (L)
M. undatus	Canthium pauciflora

In the discontinuous, sparse to locally abundant herbaceous field layer, 1 ft to 3 ft high, species found include:

Adiantum thalictroides	Oplismenus hirtellus
Begonia sutherlandii	Panicum aequinerve
Brachypodium flexum	Plectranthus fruticosus
Carex zuluensis	Polystichum ammifolium
Cyrtomium caryotideum	P. lucidum
Dietes sp.	P. luctuosum
Haemanthus katherinae	Pteris captoptera
Impatiens duthieae	Stipa dregeana
	Streptocarpus spp.

Ground layer species, up to 6 ins high, sparse to locally abundant, include:

Asplenium spp. and other small Ferns	
Lycopodium spp.	Selaginella kraussiana
Streptocarpus spp.	
Rhodobryum sp. (DE527) and other Bryophyta	

Epiphytes, principally Bryophyta, are abundant. These may be so numerous as to suggest the term 'Mossy Forest' (Photo. 112). Epiphytes include:

Bryophyta	Streptocarpus spp.
Asplenium spp.	Lichens
Peperomia reflexa	Other Ferns
P. retusa	Orchidaceae
Polypodium ecklonii	
P. lineare	

Climbers, which are generally not abundant, include:

Scutia myrtina	Cassinopsis ilicifolia
Rhoicissus tridentata	Cassine tetragona
R. revoilii	Secamone alpinii
R. rhomboidea	Riocreuxia torulosa
Clematis brachiata	Dioscorea sylvatica
Cissampelos torulosa	Buddleia auriculata
Senecio macroglossus	Chilianthus dysophyllus
S. tamoides	Potamophila prehensilis
Coccinia palmata	Behnia reticulata (L)
Melothria cordata	

The rôle played by these predominantly forest precursor climbers in the forests has been discussed for Mist Belt Mixed *Podocarpus* Forest (see (A)).

Discussion: Mountain *Podocarpus* Forest forms the

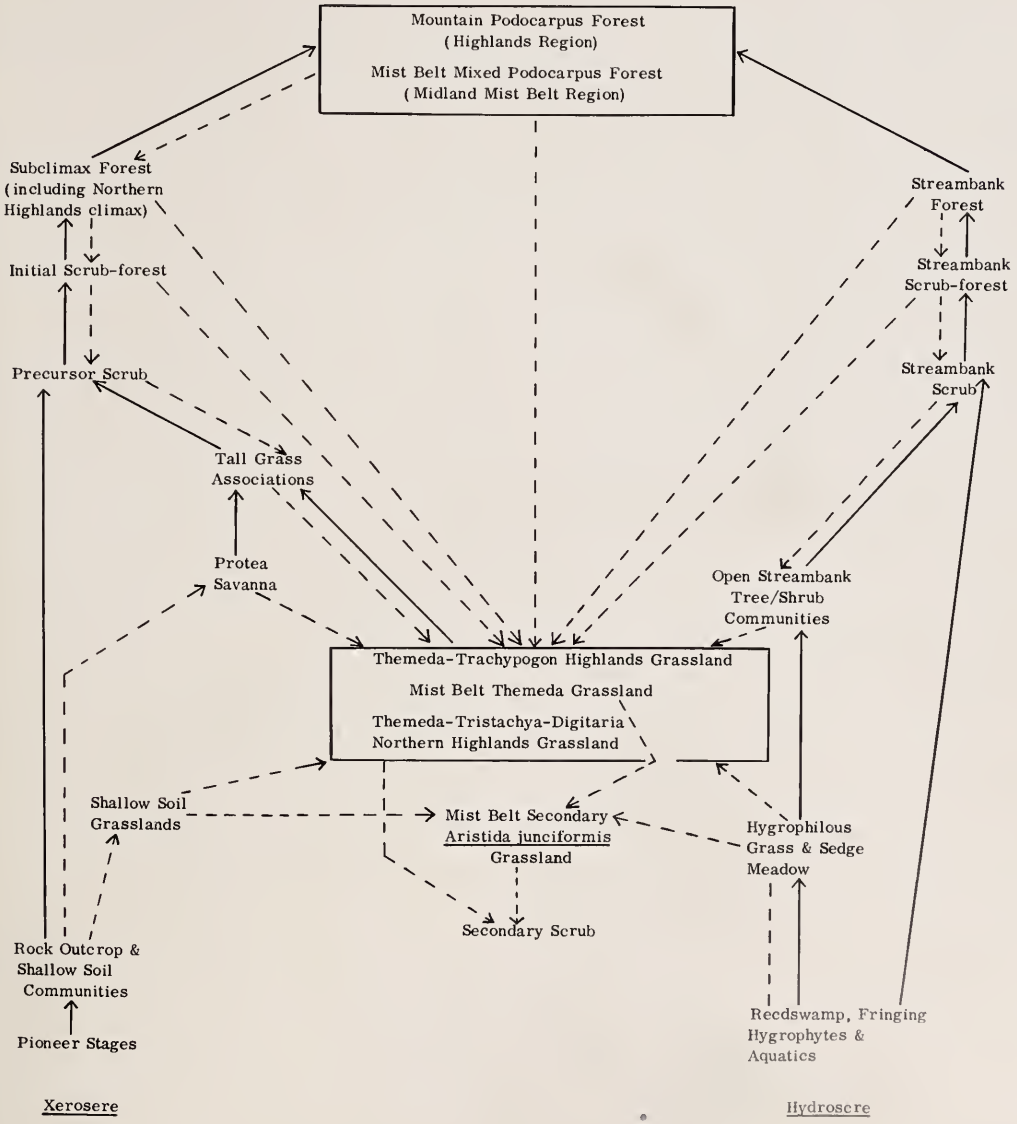


Fig. 19 Generalised Community Interrelations of Uplands Vegetation

climatic climax for most of the Highlands Region. In the drier Northern Highlands, and where frosts are severe on flat areas and in valleys, it is considered improbable that more than a scrub-forest, or a sub-climax type of forest, would develop (section 8.5 (F)). Above 6,500 ft, climatic conditions (Chapter 2) are limiting for forest. Killick (1963) has pointed out that montmorillonite clays in the basalt soils on the Little Berg may also be antagonistic to forest, but a few forest patches on basalt in the Giants Castle Game Reserve suggest that climate is the real determining factor.

As for other forest vegetation in the Tugela Basin, both historical and field evidence show that Mountain Forest was formerly more extensive. It has recently been replaced by *Themeda-Trachypogon* Highlands Grassland. The main distribution of Mountain *Podocarpus* Forest is on the Drakensberg, where there is greater protection from fire and disturbance, and frosts on the steep slopes are less severe than on less broken topography.

CHAPTER 9

MOUNTAIN VEGETATION

The vegetation of the Mountain Region covers approximately 410 square miles, or 3·7% of the Tugela Basin. Two sub-regional belts of vegetation are recognised:

(i) The Subalpine Belt, approximately 320 square miles in extent, from 6,500 ft to 9,500 ft altitude. The vegetation is chiefly transitional tropical-temperate Subalpine Grassland and Subalpine Fynbos.

(ii) The Alpine Belt, approximately 90 square miles, from 9,500 ft to *c.* 11,000 ft altitude. The vegetation is mainly temperate Alpine Grassland and Alpine Fynbos.

These vegetation belts are similar to the upper two belts described by Killick (1963) and Schelpe (1946) for the Cathedral Peak Area of the Drakensberg.

9.1 The Subalpine Belt

From the Cave Sandstone cliffs, usually marking the upper limit of forest, the Subalpine Belt extends upwards to the great basalt precipices of the High Drakensberg (Photo. 117). The lower and upper altitudinal limits of the Belt are taken here as about 6,500 ft and 9,500 ft respectively.

The Subalpine Belt forms the transition from vegetation of predominantly tropical affinities in the Uplands Regions, to that of temperate affinities in the Alpine Belt.

9.1.1 Aquatic and Hygrophilous Vegetation

Subalpine communities of aquatic and hygrophilous plants are numerous, but of small size, occurring in small vleis, in seepage areas over rocks, along streams, and rarely in and around small tarns. Because there is so much variation in the duration of water flow over rocks, it is often not possible to classify early successional vegetation as truly hydroseral or xeroseral.

(A) AQUATIC COMMUNITIES

These communities are sparsely represented in the fast-flowing streams, small vlei areas and few tarns found in the Subalpine Belt.

Submerged aquatic plants are represented by various algae and, according to Killick (1963), the mosses, *Philonotus laeviuscula* and *P. afrofontana*. Floating aquatic plants have not been observed.

Initial hydrosere stages in vleis and seepage areas over rocks are chiefly represented by low-growing rooted and partly emergent aquatics, 3 to 12 ins high. Species found include:

Anagallis huttonii	Xyris capensis
Limosella maior	Crassula natans
Eriocaulon abyssinicum	Cyperaceae spp.
E. dregei	Juncaceae spp.

(B) HYGROPHILOUS HERBACEOUS COMMUNITIES

Communities dominated by hygrophilous herbs, usually between 1 and 4 ft high, are common on moist soils (Photo. 119) at between 6,500 and 8,000 ft. Many species listed for the Uplands Hygrophilous Communities occur also in the Subalpine Hygrophilous Communities (see Chapter 7, section 7.1).

Species that dominate communities on moister soils are represented by Juncaceae, such as *Juncus exertus* and *J. rostratus*; the sedges, *Eleocharis palustris*, *Rhynchospora brownii*, *Scirpus ficinioides*, *S. nacer* and *S. spp.*; the grasses, *Arundinella nepalensis*, *Danthonia macowanii* and *Pennisetum thunbergii*; and other herbaceous plants, such as *Anoiganthus breviflorus* and *Gunnera perpensa*.

One of the most extensive and distinctive communities in marshy areas along streams, are the consocies of *Danthonia macowanii*, with sclerophyllous, sharply pointed, lightgreen leaves and large tussocks up to 4 ft high and 2 ft in diameter.

In communities on seasonally moist soils, [illegible] sedges are *Ascolepis capensis*, *Bulbostylis* [illegible], *Carex zuluensis*, *C. spp.*, *Fuirena pubesc[illegible]*, *[illegible] erecta*, *Mariscus congestus*, *Pycreus oakfo[illegible]*, *Scirpus welwitschii* and *S. woodii*. Hygrophilous grasses found are *Agrostis huttoniae*, *A. lachnantha*, *Andropogon appendiculatus*, *A. eucomus*, *Festuca sp. nov.* ([illegible])

and *Stiburus alopecuroides*. Numerous other herbaceous plants include:

Agapanthus spp.	Helichrysum spp.
Anemone fanninii	Kniphofia spp.
Aristea angolensis	Lobelia decipiens
Berkheya macrocephala	Moraea spathulata
Chironia krebsii	M. spp.
Cyrtanthus flanaganii	Orchidaceae spp.
Diclis reptans	Plectranthus calycinus
Drosera natalensis	Ranunculus cooperi
Eucomis bicolor	Satyrium neglectum
E. humilis	Sebaea spp.
Galtonia candicans	Senecio spp.
Geranium ornithopodum	Tulbaghia spp.
G. spp.	Tysonia africana
Gladiolus psittacinus	

Later hydrosere stages are dense shrubby-herbaceous communities, up to 6 ft high, with *Pteridium aquilinum*; the shrubs *Calpurnia intrusa*, *Clutia natalensis*, *Artemisia afra*, *Melianthus villosus* and *Rubus ludwigii*; the tall grasses, *Miscanthidium capense*, *Cymbopogon validus* and *Hyparrhenia aucta* and numerous herbaceous species.

Most Subalpine Hygrophilous Herbaceous Communities are burned periodically, but owing to the moist nature of the soils, burning is usually limited to the upper portions of plants and fire damage is not severe. There is a close successional relationship between the Hygrophilous Herbaceous Communities and grassland, the Communities forming the beginning of the fire deflected succession to grassland. A lowering of the soil water table thus results in an invasion by grassland.

(c) HYGROPHILOUS TREE AND SHRUB COMMUNITIES

Truly hygrophilous communities of trees and shrubs are limited in extent in the Subalpine Belt. Subalpine Fynbos and *Buddleia-Leucosidea* Scrub are common along streams where they enjoy some protection from fire (sections 9.1.4, 9.1.5). Tree and shrub communities are seldom found around vleis, where there is less protection from fires than along streambanks.

Cliffortia linearifolia, from 3 to 5 ft high, forms one of the principal hygrophilous shrub communities along streams, extending into the Uplands and Coast Hinterland Regions. In these regions, Hygrophilous *C. linearifolia* Scrub is seral to both Uplands and Semi-coast Forest, but in the Subalpine Belt *C. linearifolia* Scrub is a precursor to *Leucosidea sericea* Scrub at altitudes below 7,500 ft, and to Subalpine Fynbos above this altitude.

Hygrophilous trees and shrubs, 4 to 20 ft high, which also form communities are *Bowkeria verticillata*, *Olinia emarginata* (below 7,000 ft), *Phygelius aequalis* and *Diospyros austro-africana*.

Associated species in the various Hygrophilous Tree and Shrub Communities include those found in Subalpine Fynbos (section 9.1.5), in Subalpine *Buddleia-Leucosidea* Scrub (section 9.1.4), and in Hygrophilous Herbaceous Communities (see (b)).

9.1.2 **Cliff, Rock Outcrop and Detritus Vegetation**

The Subalpine xerosere may be broadly divided into three main habitat types:

(i) Unbroken cliffs, usually above 8,000 ft, where the main basalt cliffs occur.

(ii) Broken, weathered, rock outcrops, the main xerosere habitat type in the lower Subalpine, where the ground slopes less steeply. In the upper Subalpine, broken rock outcrops alternate with cliffs and bands of grass-covered, steep, shallow soils.

(iii) Rock detritus, mainly in the upper Subalpine.

(a) CLIFF VEGETATION

Pioneer plants on cliffs include numbers of algae, lichens and mosses, with a variety of herbs and small shrubs in crevices and on ledges. The most conspicuous and ecologically significant crevice plants are the mat-forming species, such as *Vellozia viscosa*, the sedge *Scirpus falsus* and the tunic grass *Crinipes gynoglossa* (Killick, 1963). Other common crevice and ledge plants are xeromorphic grasses, such as *Aristida galpinii*, *A. monticola*, *Pentaschistis oreodoxa* and the conspicuous tussock grass *Danthonia stereophylla*; monocotyledonous geophytes such as *Scilla natalensis* and *Eucomis humilis*; and dicotyledonous herbs and small shrubs such as *Berkheya spp.*, *Crassula spp.*, *Erica spp.*, many *Helichrysum spp.*, *Passerina montana*, *Stoebe vulgaris* and numerous other plants.

(b) ROCK OUTCROP COMMUNITIES

Algae, lichens and mosses are, as usual, the earliest plants appearing on rock outcrops, but angiospermous plants also enter early into the plant succession.

Often found on seepage areas over rocks are the mat-forming species *Vellozia viscosa*, *Crinipes gynoglossa* and *Scirpus falsus*. They are prominent in building up the soil and in providing habitats suitable for other species. Xeromorphic ferns, such as *Mohria caffrorum*, *Notholaena eckloniana*, *Pellaea calomelanos* and *P. quadripinnata*, are occasional to frequent in crevices and soil pockets.

Frequent to abundant in crevices, in soil pockets and on thin soils, are monocotyledonous geophytes, such

Photo. 74. Riverine vegetation along Tugela in Interior Basins Region. Note slumped and undercut banks. *Sphaerothylax algiformis* on submerged rocks in foreground. *Cyperus marginatus* on gravel banks, and on sand and alluvium are hygrophilous grass zones of *Hemarthria altissima*, *Beckeropsis uniseta* and *Arundinella nepalense*. Adjoining are *Hyparrhenia aucta* Tall Grass Communities. Scattered *Salix woodii* on right bank, and trees of the introduced Silver Wattle (*Acacia dealbata*) in distance. Road bridge over Tugela between Bergville and Royal Natal National Park. 15/5/57.

Photo. 73. View west across Interior Basins Region from near Winterton, showing *Themeda-Hyparrhenia* Grassland, and, in distance, South-western Highlands and snow-capped High Drakensberg. Lindeque Spruit in foreground.

Photo. 75. Initial stages of vlei hydrosere in Highlands Region, ca. 5,000 ft. Scattered stems of *Aponogeton spathaceum* and *Scirpus fluitans* in open, shallow water. Fringing hygrophyte zone of *Polygonum strigosum* and *Cyperus fastigiatus* Reedswamp at right and distance. Hlatikulu River, Giant's Castle-Kamberg road. 18/12/58.

as *Scilla natalensis*, *S. spp.* and *Rhodohypoxis baurii*; and small dicotyledonous plants of *Crassula spp.*, *Helichrysum spp.*, *Oxalis spp.*, *Psammotropha myriantha*, *Indigofera hedyantha*, *Wahlenbergia montana* and many others. These monocotyledonous and dicotyledonous herbs may be mixed in various proportions with Rock Outcrop and Shallow Soil Grass Communities, in which the earliest grasses are *Aristida galpinii*, *A. monticola*, *Digitaria monodactyla* and *Microchloa caffra*, followed by *Eragrostis caesia*, *E. capensis*, *E. racemosa*, *Rendlia altera*, *Rhynchelytrum setifolium*, *Sporobolus centrifugus*, *Loudetia simplex* and *Andropogon filifolius*. These grass communities are only occasionally burned, and because the plant cover is generally low, numbers of fire-sensitive plants, such as Fynbos shrubs, may be present. Forbs of *Themeda-Festuca* Grassland (section 9.1.3) may be frequent.

Amongst the earliest woody plants are succulent low shrubs, less than 2 ft high, of *Crassula harveyi* and occasionally *Aloe boylei*. Numerous Fynbos shrubs, less than 3 ft high (see also section 9.1.5), appear early in the succession, in crevices and on shallow, stony soils, where they are somewhat protected from fire. Typical low shrubs found include (L = Lower Subalpine; U = Upper Subalpine):

Erica spp.	Passerina montana (U)
Aster filifolius	Phylica thodei
Buchenroedera lotonoides	Polygala hispida
	Protea dracomontana (L)
Chrysocoma tenuifolia	Rhus discolor (L)
Cliffortia repens (L)	Muraltia saxicola (U)

Frequently *Protea rouppelliae* and occasionally *P. subvestita* occur on very shallow soils overlying Cave Sandstone and basalt at the lower limits of the Subalpine Belt (Chapter 8).

Development of the xerosere on rock outcrops and shallow, stony soils is related to the incidence of fire. Where fires are frequent, development is to Subalpine *Themeda-Festuca* Grassland. In the absence of fires the succession is towards Subalpine Fynbos or Subalpine *Buddleia-Leucosidea* Scrub. Clearly defined successional trends are not always apparent, however, owing to the numerous niches in which fire-sensitive plants are able to survive. Rock Outcrop Communities thus frequently contain a mixture of species of the normal or undeflected succession to Fynbos, and of the deflected grassland succession occurring in the presence of fire.

(c) ROCK DETRITUS COMMUNITIES

These communities occur on rock detritus below cliffs and in deep gullies and ravines. The detritus is composed of rock fragments, ranging from large blocks on steep scree slopes, to gravel and coarse sands found between the larger rock fragments in less steep gullies and along dry stream beds. The detritus is characterised by its instability and by flash floods from heavy storms during the summer months. Fairly stable detritus in deep, protected gullies carries dense scrub communities of *Leucosidea sericea* or Subalpine Fynbos (see sections 9.1.4 and 9.1.5).

Open communities, from 1 to 2 ft high, are formed on steep scree in the upper Subalpine by the wiry-leaved tussock grasses, *Danthonia stereophylla* and *D. aureocephala*, the succulent low shrub, *Crassula harveyi*, and the fern, *Polystichum lucidum*.

9.1.3 Subalpine Grassland

Subalpine Grasslands form a transition from Uplands *Themeda triandra* Grasslands to Alpine Grasslands dominated by *Festuca*, *Danthonia* and *Pentaschistis*. The grasses of the tropical Uplands decrease in importance but temperate species increase in importance with altitude.

On the rugged mountain terrain there are continuous intergradations between grassland best developed on deeper soils, and the xerosere and fire-sensitive shrub communities developed principally on rock outcrops and stony, shallow soils. Grass communities on moist and rocky situations are discussed in sections 9.1.1 and 9.1.2 respectively.

On steep mountain slopes, the bunch grass growth form is accentuated by soil accumulation on the upper sides of grass tufts and by soil removal below the tufts. A stepped effect is thus often evident on the steep slopes (West, 1951; Killick, 1963).

(a) SUBALPINE THEMEDA-FESTUCA GRASSLAND

This is the most extensive plant association in the Mountain Region (Photos. 117, 118). It occurs also in the Uplands Regions, with the most eastern outlier at approximately 5,800 ft altitude near Ntshiza on the Qudeni massif. Subalpine *Themeda-Festuca* Grassland is also found occasionally on exposed hill-tops from Mt. Alida and Mt. Gilboa westwards through the Highlands Region to the Drakensberg.

Below 8,500 ft in the Subalpine Belt, communities of *Themeda triandra* and *Festuca costata* occupy warm north-facing and cool south-facing slopes respectively. In the lowest part of the Subalpine Belt *Themeda* Consociations resemble *Themeda* Highlands Grassland, but temperate species are fewer

prominent. On north aspects above 8,500 ft, associations of *Themeda* and Festuca preponderate; on south-facing slopes, *Festuca* Consociations have more temperate species than at lower altitudes.

During autumn and winter, *Festuca costata* is easily recognised by its bright green colour and tussock character in relation to the surrounding bleached, pink, and purple tinted shorter grasses.

Common to abundant and dominant grasses are (L = Lower Subalpine; U = Upper Subalpine):

Themeda triandra	Heteropogon contortus (L)
Festuca costata	Koeleria cristata
Andropogon appendiculatus	Monocymbium ceresiiforme
A. filifolius	Stiburus alopecuroides
Eragrostis capensis	Trachypogon spicatus (L)
E. racemosa	Tristachya hispida
Harpechloa falx	

Occasional to frequent or locally dominant grasses include:

Agrostis barbuligera	Eragrostis caesia
Alloteropsis semialata	Ehrharta longigluma
Andropogon distachyus	Festuca caprina
A. sp. cf. A. pratensis (DE2133)	F. scabra
A. sp. nov. (DE1148)	Helictotrichon hirtulum
Anthoxanthum ecklonii	H. longifolium
Aristida galpinii	Hyparrhenia hirta (L) (secondary)
A. monticola	Loudetia simplex
Bromus speciosus	Microchloa caffra
Cymbopogon validus (L)	Panicum ecklonii
Danthonia stricta	P. natalense
D. aureocephala	Pentaschistis natalensis
Digitaria monodactyla	Poa binata
Elyonurus argenteus	Rendlia altera

Associated non-grass plants are exceedingly numerous, forming many seasonal and local societies. Shrubby plants, such as *Erica spp.*, occur principally in short, open grassland on shallow soils. Conspicuous forbs are *Erica spp.* and *Helichrysum spp.* Forbs found include:

Acalypha punctata	Hypoxis spp.
Agapanthus spp.	Indigofera hedyantha
Albuca spp.	I. spp.
Aloe boylei	Kniphofia spp.
A. saponaria	Lessertia thodei
Anthericum spp.	L. spp.
Apodolirion spp.	Lotononis galpinii
Aristea spp.	L. spp.
Aster bakerianus	Manulea thodiana
A. filifolius	Metalasia muricata
A. perfoliatus	Monsonia attenuata
Berkheya spp.	Moraea spp.
Buchenroedera lotonoides	Muraltia saxicola
	Myrica serrata
Buplureum mundtii	M. pilulifera
Chrysocoma tenuifolia	Orchidaceae spp.
Cycnium racemosum	Ornithogalum spp.
Cyperus semitrifidus	Passerina montana
C. compactus	P. sp. (=DE973)
Cyphia elata	Protea dracomontana
Dianthus spp.	Polygala hispida
Diascia purpurea	P. spp.
Dierama medium	Restio spp.
Elsiea flanaganii	Rhodohypoxis baurii
Erica caffrorum	Rhus discolor
E. cerinthoides	Scabiosa columbaria
E. oatesii	Schizoglossum homatum
E. westii	S. spp.
E. woodii	Scilla natalensis
E. spp.	S. spp.
Eucomis bicolor	Scirpus falsus
E. humilis	Sebaea sedoides
Ficinia cinnamomea	Senecio erubescens
F. gracilis	S. pauciligulatus
Fuirena pubescens	S. spp.
Galium wittebergense	Sopubia cana
Gladiolus longicollis	Sutera breviflora
Gnidia fastigiata	Tetraria cuspidata
Hebenstreitia dentata	Thesium acutissimum
Helichrysum aureonitens	T. nigrum
H. fulgidum	T. racemosum
H. infaustum	Tulbaghia spp.
H. grandibracteatum	Tysonia africana
H. latifolium	Urginea spp.
H. scapiforme	Vernonia hirsuta
H. scopulosum	Watsonia densiflora
H. squamosum	Zaluzianskaya maritima
H. sutherlandii	
H. spp.	

Grazing of Subalpine *Themeda-Festuca* Grassland is by relatively sparse antelope populations of the Giants Castle Game Reserve and Royal Natal National Park. Under such light grazing the exclusion of fire, for periods longer than two years, results in a considerable accumulation of organic material and a reduction in the vigour of the grasses so that subsequent fires are fierce, resulting in considerable damage. In the absence of burning, development of Subalpine *Themeda-Festuca* Grassland is towards *Buddleia-Leucosidea* Scrub in the lower Subalpine Belt, and towards Subalpine Fynbos in the upper Subalpine Belt.

(B) PENTASCHISTIS TYSONII GRASSLAND

This community was first described by Killick (1963). Dense, sward forming, wire leaved *P. tysonii* Grassland occurs on south aspects, from 6,000 to 7,500 ft, and also on north facing slopes above 7,500 ft. The Grassland occurs on moister slopes than does *Festuca costata* Grassland.

In deep gullies and on steep south facing slopes at high altitudes, *P. tysonii* Grassland is often covered by snow for about a month during winter. In the absence of a snow cover, moist soils have been observed to remain frozen for several weeks.

The associated grasses are relatively few and include a number of temperate and moisture loving species:

Agrostis barbuligera	Harpechloa falx
Andropogon appendiculatus	Koeleria cristata
	Pentaschistis oreodoxa

Bromus speciosus
Danthonia stricta
Elyonurus argenteus
Festuca caprina
P. pilosogluma
Poa binata
Sporobolus centrifugus

(c) SUBALPINE OPEN SHRUB COMMUNITIES

Open shrub communities, up to 5 ft high, with a *Themeda-Festuca* grass stratum, are formed by the species, *Protea dracomontana* (see Chapter 8), *Buchenroedera lotononoides* and *Rhus discolor*. The bushy leguminous shrub, *B. lotononoides*, often covers considerable areas and, like the other two species, sprouts from a woody rootstock after burning. Successionally, the communities are related to Subalpine Fynbos, towards which development occurs in the absence of fire.

9.1.4 Subalpine Buddleia-Leucosidea Scrub

These scrub or sometimes woodland communities occur principally in the lower Subalpine Belt, extending occasionally up protected gullies to below the main escarpment cliffs. They represent upward extensions into the Subalpine Belt of Uplands forest precursor communities, occurring locally along streams, on stream boulder beds and on gully and slope talus.

(a) SUBALPINE LEUCOSIDEA SCRUB AND WOODLAND

L. sericea Scrub and Woodland, 8 to 15 ft high, occurs chiefly between 6,500 ft and 7,500 ft altitude. Woodland, with sparse shrub and field layers below the tree canopy, occurs where it is protected from fire. Commonly, a periodically burnt scrub is found, composed of predominantly shrubby *Leucosidea sericea*. Eland inhabit and browse the scrub and woodland.

Associated shrubs and small trees, from 5 to 20 ft high, are (S = Streambanks):

Buddleia salviifolia
Philippia evansii
Rhus dentata
Diospyros austro-africana
Rhamnus prinoides
Cliffortia linearifolia (S)
Bowkeria verticillata (S)
Maytenus acuminatus
Halleria lucida
Olinia emarginata
Ilex mitis (S)

Myrsine africana forms a small shrub layer, 2 to 3 ft high.

In the herbaceous stratum, up to 3 ft high, are the ferns, *Pteridium aquilinum* and *Polystichum spp.*, and the sedges, *Carex spicato-paniculata* and *Cyperus zuluensis*. Climbers include *Clematis brachiata* and *Riocreuxia torulosa*.

On margins of the Scrub and Woodland are tall grasses, such as *Cymbopogon validus* and *Miscanthidium capense*; bracken (*Pteridium aquilinum*); shrubs, such as *Euphorbia epicyparissias* and Fynbos spp. (section 9.1.5); and numerous herbaceous species.

Although *Leucosidea* communities are commonly connected with the plant succession along streams, the species also invades the lower Subalpine Grasslands. *Leucosidea* Woodland represents the principal climatic climax community in a zone of approximately 1,000 ft altitude between the Mountain *Podocarpus* Forest climax and the main Subalpine Fynbos climax above 7,500 ft altitude.

(b) BUDDLEIA SCRUB

B. salviifolia Scrub, from 4 to 10 ft high, occurs occasionally in the lower Subalpine Belt in drier situations than does *Leucosidea sericea* (see Chapter 8, section 8.5).

Scrub communities of *B. corrugata*, from 3 to 5 ft high, occur on scree and below cliffs in the upper Subalpine Belt, between 8,000 ft and 9,500 ft. The species resembles *B. salviifolia* and is easily mistaken for that plant.

9.1.5 Subalpine Fynbos

One of the features of the Mountain Vegetation is the considerable development of evergreen small ericoid leaved shrub vegetation, or Fynbos, physiognomically similar to that found in the south-western Cape Province. In the Subalpine Belt, Fynbos is from 3 to 10 ft high, varying in density from an open shrub community, associated with grassland, to dense scrub. The communities are best developed along streams, in gullies, on steep slopes and on rock outcrops, situations where there is protection from fire.

Subalpine Fynbos represents the principal climatic climax community of the Subalpine Belt of the Drakensberg, but at lower altitudes Fynbos is seral to forest (Chapters 5 and 8).

(a) PASSERINA-FILIFORMIS FYNBOS

This is a relatively open community, from 2 to 4 ft high, occurring up to 8,000 ft altitude on rocky slopes. Local communities occur also in the Uplands and Coast Hinterland Regions on exposed, rocky summit areas

(b) CLIFFORTIA FYNBOS

C. linearifolia Streambank Scrub (see section [illegible]) often found, but communities of *C. repens* and [illegible] *dula*, are not common (see Chapter 8, sections [illegible])

(c) WIDDRINGTONIA DRACOMONTANA [illegible]

In gullies and on steep slopes there are dense [illegible] munities, from 5 to 15 ft high, of the Berg Cypress

The communities extend from 5,000 ft in the Highlands Region to 8,500 ft in the Subalpine Belt. Below 6,500 ft the communities are seral to forest. Because of its high resin content *W. draconontana* is readily inflammable and thus frequently fire damaged.

(D) ERICA-PHILIPPIA FYNBOS

Communities, from 3 to 10 ft high, with *Erica spp.* and *Philippia evansii* as the principal species, form the chief Fynbos vegetation of the Subalpine Belt. Species occur in a number of associations and consociations. *Protea dracomontana* and *P. subvestita* are occasionally prominent with *Erica spp.* in protected situations, forming a Fynbos very similar in appearance to that found in the Western Cape (Photos. 104, 120). Communities on shallow soils have fewer species than those on deeper or moister soils. Where the Fynbos is burnt, grasses and associated grassland plants may become important.

The principal shrubs found are:

Erica ebracteata	Euryops evansii
E. drakensbergensis	E. tysonii
E. natalitia	Phylica thodei
E. westii	Calpurnia intrusa
Philippia evansii	Clutia natalensis
Widdringtonia draco-montana	Melianthus villosus
Passerina montana	Anthospermum aethio-picum
P. filiformis	Myrsine africana
Protea dracomontana	Euphorbia epicyparissias
P. subvestita	Rhus discolor
Encephalartos ghellinckii	R. dentata
Macowania conferta	Stoebe vulgaris
Artemisia afra	Psoralea caffra
Diospyros austro-africana	Polygala myrtifolia
Syncolostemon macran-thus	Asparagus spp.
	Berkheya draco
Buchenroedera lotono-noides	Helichrysum tenax
	Lasiosiphon anthylloides
Anthanasia montana	Athrixia pinifolia
A. punctata	

Grasses and other herbs found amongst the shrubs include:

Cymbopogon validus	Anemone fanninii
Berkheya macrocephala	Geranium spp.
Polystichum spp.	Indigofera cuneifolia
Mohria caffrorum	Helichrysum spp.
Festuca costata	Berkheya spp.
Pentaschistis pilosogluma	Cyperus zuluense
Scilla natalensis	Carex spicato-paniculata

9.2 The Alpine Belt

The Alpine Belt extends in a narrow strip along the summit area of the High Drakensberg from Mont aux Sources to south of Giant's Castle. The influence of the climatic conditions is seen in the xeromorphic character of the vegetation, and in frost action on soils and vegetation (Chapter 2). The principal plant communities are Alpine *Danthonia-Festuca-Pentaschistis* Grassland and Alpine *Erica-Helichrysum* Fynbos. Plants of temperate affinities are dominant in the vegetation.

9.2.1 Aquatic and Hygrophilous Vegetation

On the undulating summit area of the High Drakensberg are numerous sponges and streams, which form the headwaters of the Tugela and Orange River systems. Following Killick (1963), upon whose account the following is largely based, the aquatic and hygrophilous vegetation may be divided into that of flushes, pools, streams and mud patches.

(A) FLUSH COMMUNITIES

Boggy communities occur over springs and seepage areas. In the initial stages of the hydrosere are several mosses, particularly *Grimmia apocarpa.* Subsequent stages are dominated by *Haplocarpha sp.*, with *Scirpus fluitans*, *Athrixia fontana*, *Agrostis huttoniae*, *Limosella longiflora*, *Ericaulon dregei* and, more rarely, *Berkheya multijuga* and *Kniphofia caulescens* as associates.

(B) POOL COMMUNITIES

In temporary pools, common during summer, *Aponogeton spathaceum* is the only aquatic present. Around the pools are herbaceous plants such as *Ranunculus cooperi*, *R. baurii*, *Senecio cryptolanatus*, *Eriocaulon dregei* and *Kniphofia caulescens.*

(C) STREAMBANK COMMUNITIES

Along the small clear streams of the Alpine summit area, herbaceous communities, up to 3 ft high, are dominated by *Danthonia drakensbergensis*, *Kniphofia caulescens*, *Berkheya multijuga*, *Polygonum sp.*, *Senecio achillaefolius*, *S. cryptolanatus* and *Juncus exertus.* Shrubs, up to 3 ft high, that enjoy the protection from fire afforded by streambanks, are *Erica thodei*, *E. alopecuroides*, *Cliffortia browniana* and *Euryops montanus*, together with various other Alpine Fynbos species (section 9.2.4).

(D) MUD PATCH COMMUNITIES

On the summit area of the Drakensberg are numerous bare, or almost bare soil areas, termed 'mud patches' by Schelpe (1946). During summer the mud patches are wet, sometimes covered by water to an inch or more in depth. During winter, however, the surface soil commonly exhibits a 'raked appearance' and frequently becomes dry. Most significant for plant growth is the winter frost action in these mud patches (see Chapter 2), and plants are often seen partially lifted out of the soil.

Several small herbaceous plants form open com-

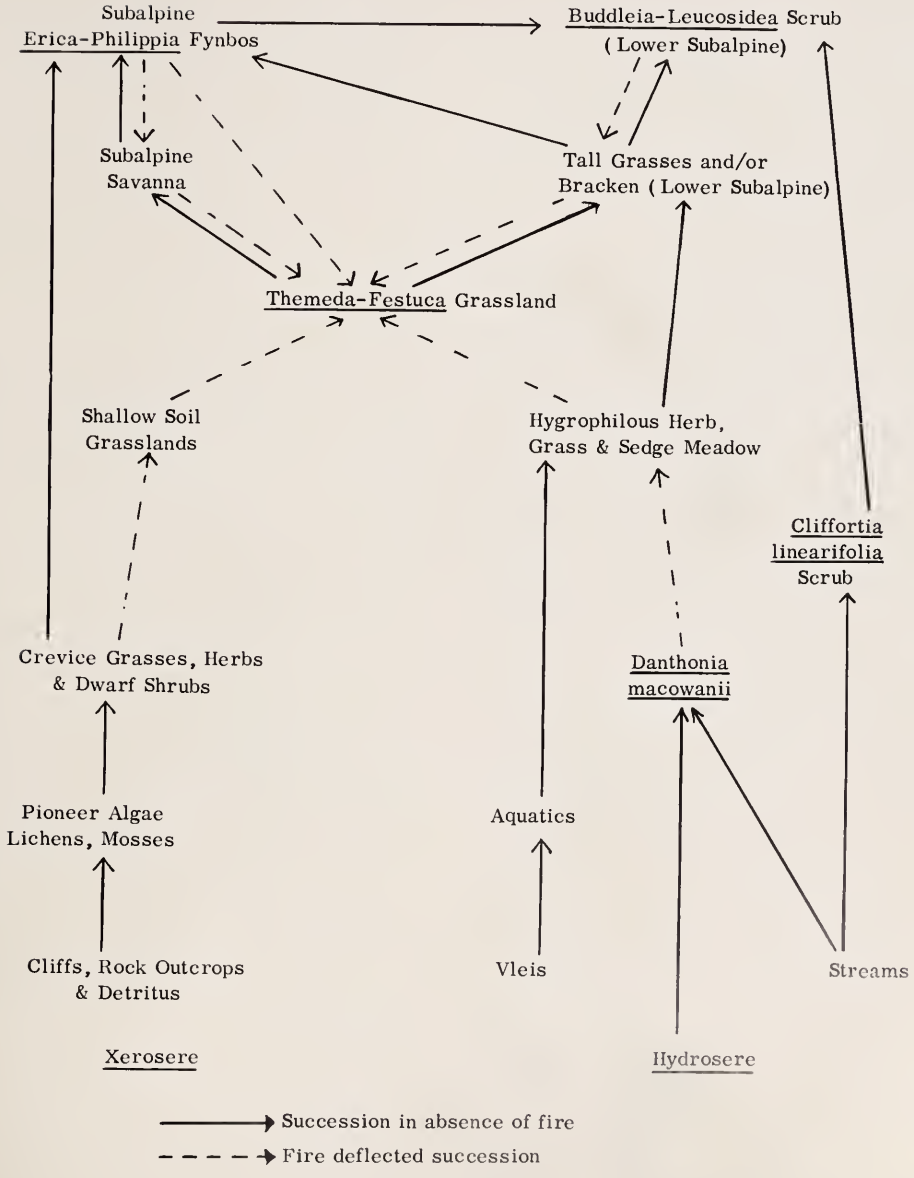


Fig. 20 Generalised Community Interrelations in the Subalpine Belt

munities in the mud patches. According to Killick (1963), such plants are *Felicia pinnatifida*, *Psammotropha alternifolia*, *Crassula natans*, *Rhodohypoxis rubella*, *Limosella capensis*, *L. longiflora* and *Juncus exertus*.

Communities of the hygrophilous tussock grass, *Danthonia drakensbergensis*, and the Alpine Fynbos shrub, *Helichrysum trilineatum* var. *tomentosum*, are often associated with the mud patches.

(E) ALPINE SEDGE MEADOW

According to Killick (1963), a low, continuous turf, 2 to 4 ins high, dominated by the two sedges, *Carex monotropa* and *C. killickii*, is found on moist, but firm, ground on the summit area. Associated species are *Sebaea thodeana*, *Geranium incanum*, *Schoenoxiphium filiforme*, *Trifolium burchellianum*, *Luzula africana*, *Elsiea tysonii*, *Helichrysum subglomerata*, *Moraea sp.*, *Eragrostis caesia* and *Koeleria cristata*.

The community occasionally exhibits a hummock structure due to the activities of a mole or mole rat and to trampling by cattle (Killick, 1963). Hummock formation by a mole or mole rat is of interest, since it parallels hummock formation in the sedge meadow of certain vleis of the Highlands Region, where it is due to the activities of ants (see Chapter 7, section 7.1).

9.2.2 **Cliff, Rock Outcrop and Detritus Vegetation**

This vegetation, physiognomically distinguished from its subalpine counterpart by its low, stunted and more open character, occurs above 9,000 to 9,500 ft altitude. Local climatic factors, particularly wind, and, during winter, snow and ice, are important determining factors in the initial stages of plant colonisation.

(A) CLIFF VEGETATION

Though the main, sheer cliffs of the escarpment bear relatively little vegetation, the walls of steep sided gullies, that cut back into the escarpment, are broken and have a considerable amount of open vegetation. Algae and lichens occur on rock faces, mosses in small cracks and soil pockets, and a variety of herbaceous and shrubby plants (see (B)) in the larger crevices and on ledges.

(B) ROCK OUTCROP COMMUNITIES

Where the rocks are broken and strongly weathered, a variety of plants occurs in crevices and on ledges. Characteristic are the strongly rooted tussock grass, *Danthonia stereophylla*, the tough mat forming sedge, *Scirpus falsus*, and a number of cushion plants, particularly *Helichrysum spp.* Other plants include:

Vellozia viscosa	Pellaea calomelanos
Helichrysum splendidum	Eragrostis caesia
H. scopulosum	Bulbostylis humilis
H. milfordiae	Crassula muscosa
H. spp.	Glumicalyx montana
Muraltia saxicola	Ursinia montana
Psammotropha alternifolia	Alpine Fynbos spp.
P. mucronata	

At the base of cliffs, small herbaceous communities, up to 3 ft high, of *Kniphofia northiae*, *K. spp.*, *Cyrtanthus flanaganii*, *Zaluzianskya spp.* and Alpine grasses are found.

(C) DETRITUS COMMUNITIES

Detritus habitats in the Alpine Belt are of two types:

(i) Scree, on steep slopes, mainly at the heads of gullies that cut back into the escarpment; and (ii) Summit Detritus, on the undulating summit area, where there is little gravitational movement of the rock debris. In summit detritus, frost, water and wind erosion of any soil build-up tend to retard progressive plant colonisation.

Many of the species of Rock Detritus Communities occur also in the Rock Outcrop Communities (see (B)).

On gully scree *Danthonia stereophylla* is a common species.

On windswept summit detritus, crustose and foliose lichens are frequent. Angiosperm species show considerable deformation, and xeromorphic features, such as low cushion forms, close branching and woolly leaf coverings, are common. The sedge, *Scirpus falsus*, forms extremely tough, thick root mats over the rock surfaces. Alpine grasses, herbs and shrubs (sections 9.2.3, 9.2.4) grow in crevices and in soil pockets, and invade communities of earlier mat and cushion plant colonisers.

9.2.3 **Alpine Grassland**

Alpine Grasslands are well developed and extensive on the summit area of the High Drakensberg, sometimes extending down gullies to 9,000 ft altitude. The communities range from local, wire leaved tussock grasslands to dense sward types.

(A) DANTHONIA TUSSOCK GRASSLAND

Danthonia Tussock Grasslands are composed of strongly rooted, hard, wire leaved grasses with large, dense tufts or tussocks, up to 3 ft high. Around sponges and mud patches, *Danthonia drakensbergensis* is dominant, but on rocky areas, the closely related species, *D. stereophylla*, is the principal grass (Photo. 122).

The tussock grasses are badly injured by fire, and are

thus largely confined to fire-protected moist or rocky habitats.

(b) DANTHONIA-FESTUCA-PENTASCHISTIS GRASSLAND

This is the principal plant association of the summit area, forming a dense to relatively open sward, up to 2·5 ft high (Photo. 123).

Common to abundant and dominant grasses are:

Danthonia disticha	Koeleria cristata
Pentaschistis oreodoxa	Agrostis barbuligera
Festuca caprina	Harpechloa falx
Poa binata	

Occasional to frequent or locally dominant grasses include:

Aira caryophyllea	Eragrostis caesia
Agrostis subulifolia	Ehrharta longigluma
Anthoxanthum ecklonii	Festuca costata
Brachypodium bolusii	F. scabra
Danthonia drakensberg-ensis	Helictotrichon hirtulum
	Stiburus alopecuroides
D. stereophylla	

Grassland forbs are generally localised. *Helichrysum spp.* and *Erica spp.* may be conspicuous. The species present include:

Athanasia montana	H. trilineatum
Basutica aberrans	H. spp.
Berkheya multijuga	Kniphofia spp.
Clutia nana	Lessertia thodei
Cyrtanthus flanaganii	Lotononis galpinii
Dianthus spp.	Moraea spathulata
Diascia sp. nov. (DE1166)	M. spp.
Dierama spp.	Muraltia flanaganii
Disa chrysostachya	M. saxicola
Elsiea spp.	Myosotis afropalustris
Erica algida	Polygala hispida
E. alopecurus	Psammotropha alternifolia
E. frigida	Satyrium cristatum
E. thodei	S. spp.
E. sp. (DE360)	Scabiosa columbaria
E. spp.	Scirpus falsus
Euryops evansii	Sebaea procumbens
Hirpicium armerioides	S. spathulata
Glumicalyx montana	Senecio tugelensis
Hebenstreitia dentata	S. spp.
Helichrysum adenocarpum	Sutera sp. (DE 1157)
H. infaustum	Thesium racemosum
H. marginatum	T. rasum
H. retortoides	Ursinia montana
H. rugulosum	Wahlenbergia montana
H. scapiforme	Wurmbea kraussii
H. squamosum	Zaluzianskya alpestris
H. stoloniferum	Z. ovata
H. subglomeratum	

Danthonia-Festuca-Pentaschistis Grassland is lightly grazed by Basuto owned horses and cattle. Burning, which seems to occur at least once every five years, has been observed in autumn. Little secondary modification of the grassland has been observed.

9.2.4 Alpine Fynbos

On the summit area of the Drakensberg there are open, dwarf shrub communities, 0·5 to 2·5 ft high, of *Erica spp.*, *Helichrysum spp.* and other temperate species. The term 'Alpine Fynbos' is used here to denote these communities. The word 'Alpine' indicates the general physiognomic, xeromorphic and habitat features resulting from the montane climate. 'Fynbos' indicates the affinities with vegetation, generally termed 'Fynbos', found at lower altitudes in the Tugela Basin and in the south-western Cape Province. Other terms to describe Alpine Fynbos are considered unnecessary.

(a) ALPINE ERICA-HELICHRYSUM FYNBOS

This comprises several associations and consociations. The most extensive consociation is an open, low shrub community, 0·5 to 2 ft high, of *Erica sp.* (= DE360) (Photo. 121). Associations with *Helichrysum trilineatum* are common, this species also forming consociations. Killick (1963) records consociations of another similar undescribed *Erica sp.* (= Killick 1729) on moister, more protected habitats. He also describes as Boulder-field Heath, a taller, 2 to 4 ft high, Fynbos of *Athanasia thodei*, *Helichrysum trilineatum* and *Eumorphia sericea* occurring on boulder strewn habitats, where there is some protection from fire, and probably from unfavourable climatic factors.

On rocky habitats, local consociations and associations are found of *Helichrysum trilineatum*, *Passerina montana*, *Euryops montanus* and *Chrysocoma tenuifolia*. The tussock grass, *Danthonia stereophylla*, is a frequent associate on these rocky habitats.

Along streambanks, *Cliffortia browniana* and *Helichrysum trilineatum* often form a narrow shrub zone.

The principal species found in Alpine Fynbos are:

Erica sp. (= DE 360)	Athanasia thodei
E. sp. (= Killick 1729)	Eumorphia sericea
E. flanaganii	Lotononis galpinii
E. thodei	Clutia nana
Helichrysum trilineatum	Basutica aberrans
Chrysocoma tenuifolia	Euryops acraeus
Cliffortia browniana	Anthospermum hispidulum
Passerina montana	Selago flanaganii
Euryops montanus	

Alpine grasses and their associated plants (see section 9.2.3) are ccasional to frequent with the dwarf shrubs.

The climax of the Alpine Belt is considered to be the *Erica sp.* (= DE360)-*Helichrysum trilineatum* Alpine Fynbos, the species occurring in associations consociations. Other Alpine Fynbos communities interpreted as local edaphic or postclimax communities. Fires limit or deflect the Alpine Fynbos plant succession resulting in the development of *Danthonia-Festuca-Pentaschistis* Grassland. But the incidence of fire is considerably less than in vegetation at lower altitudes.

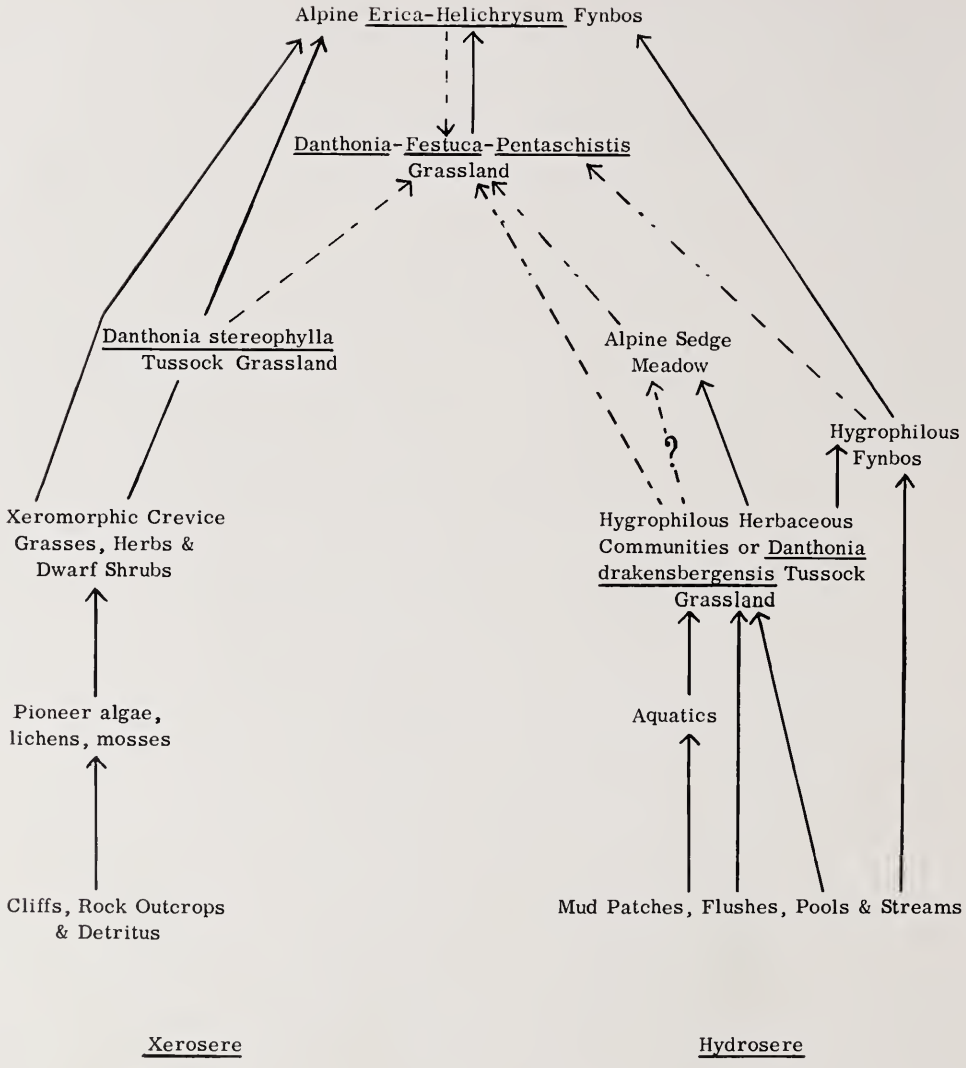


Fig. 21 Generalised Community Interrelations in the Alpine Belt

Photo. 76. Pond surface covered with aquatics, *Potamogeton nodosus* (emergent flowering spikes and large leaves), and the minute *Wolffia sp.* The submerged aquatic, *Lagarospihon muscoides*, is not visible. At left is the fringing hygrophyte, *Scirpus inclinatus*. Interior Basins Region. 19 miles from Bergville on Rustenberg road. 17/12/58.

Photo. 77. Rush, sedge and hygrophilous grass fringing hygrophytes of *Juncus exertus*, *J.punctorius*, *Scirpus paludicola*, *Cyperus marginatus* and *Leersia hexandra*. Left and centr is *Miscanthidium junceum* Reedswamp. Interior Basins Region. Six miles from Geluksberg on Bergville road. 6/12/58.

Photo. 78. Hummocks inhabited by the ant, *Euponera* (*Trachymesopus*) *wroughtonii* Forel var. *crudelis*, in Hygrophilous Grass and Sedge Meadow. Highlands Region. Hlatikulu River, Giant's Castle-Kamberg road.

Photo. 79. Effect of different grazing and management systems on Moist Transitional *Themeda-Hyparrhenia* Grassland. Left of fence: continuously overgrazed Bantu area, showing short grass cover breaking down to bare ground. Right of fence: foreground, recently autumn burnt camp on European farm, after long rest, probably at least two years; in middle and far distance are unburnt parts of camp (see Photo. 80 for detail). Boundary of Klein-fontein Location, Bergville district. 1/5/63.

CHAPTER 10

LITERATURE AND GENERAL SUMMARY

The vegetation of Natal has been classified in various ways by different authors. As applied to the Tugela Basin, these classifications are summarised in Table 9. In some instances the correlations must be regarded as approximate only, because of the general nature of some accounts and the absence of vegetation maps.

Table 9 shows that although there is general agreement on the delimitation of the Coast Lowland vegetation, there is less agreement on the classification of the vegetation further inland.

The classification by Thode (1901) is chiefly of historical interest. His division of Natal into three main regions occurs also in later works.

The classifications by Pole Evans (1936) and Adamson (1938), covering the whole of South Africa, were to a large extent based on the broad physiognomic features of the vegetation. Pole Evans made a clear distinction between the grasslands of Natal and of the High Veld, whereas Adamson emphasised the predominance of grassland in the interior areas of the Tugela Basin and of tree and shrub vegetation in the lower Midland areas (Table 9).

Bews (1912–1920) and Bayer (1938) used the term 'Midland' to cover a wide region between the Coastbelt and the Mountain Region (Bews, 1917). Midland vegetation thus ranged from xerophytic valley scrub to moist forest. Recognising this variety of vegetation, Bayer regarded the vegetation of the elevated moist areas in Zululand as postclimax grassland and forest, and that in the dry valleys as Deciduous Tall or Short Tree Savanna, whereas Bews, in Natal, grouped it into High Veld and Low Veld types.

Adopting an ecological regional approach, Pentz (1940, 1945), Acocks (1953) and the present author have divided the former Midland vegetation into several types. The vegetation of the drier valleys has been separated, and the Midland Forest and Grassland has been divided into that of the Coast Hinterland and Midland Mist Belt Regions (cf. also Acocks), with affinities to Coast and Uplands Vegetation respectively.

The regional groupings were all accorded equal status by Pentz, but Acocks classified his 'Veld Types'* under major vegetation units. The ecological classification used in this account of the vegetation of the Tugela Basin is similar, in many respects, to those of Pentz and Acocks. It differs, however, in emphasising climate and the climatic climax as the basis for the regional classification. For example, Pentz accorded *Tristachya-Digitaria* Grassland and *Themeda-Hyparrhenia* Grassland equal status, whereas Acocks grouped them under False Grassveld Types. In the present account, the two grasslands are included under the Interior Basins Region, throughout which the climate and the climatic climax are similar, but the differing soil conditions give rise to the two grasslands mentioned above. Because of the relatively dry, warm climate (Chapter 2), the nature of the climatic climax (Chapter 6), the partly leached nature of the soils (Chapter 3) and relatively tall character of the grasses, the grasslands of the Interior Basins Region are classified under the general heading of Savanna Vegetation, together with the vegetation of the Valley Region (see following summary).

This account also differs from Acocks (1953) in regarding the vegetation of the High Drakensberg as a distinct Montane type. Its Afro-alpine character has been discussed by Killick (1963), whose division into Subalpine and Alpine Belts is in accordance with the classification proposed by Hedberg (1951) for mountain vegetation in Central and East Africa.

SUMMARY OF PRINCIPAL ECOLOGICAL FEATURES OF THE TUGELA BASIN, NATAL

Total area: 11,200 square miles
Altitude: 0 to *c.* 11,000 ft
Latitude: 27° 20′ to 29° 30′ S
Longitude: 28° 55′ to 31° 30′ E

* A Veld Type is defined by Acocks (1953) as [illegible] vegetation whose range of variation is small enough to permit the whole of it to have the same farming potentialities.

Table 9. COMPARISON OF REGIONAL CLASSIFICATIONS OF PRINCIPAL VEGETATION TYPES OF THE TUGELA BASIN, 1901-1963

Thode (1901)	Bews (1912-1920)	Pole Evans (1936)	Adamson (1938)	Bayer (1938)	Pentz (1940, 1945)	West (1951)	Acocks (1953)	Edwards (1963)
COASTBELT	COASTBELT Coast Forest (1920); Coast Scrub and Treeveld (1920)	Evergreen and Deciduous Bush and Subtropical Forest	Subtropical Forest	COASTBELT Evergreen Subtropical Forest; Coast Evergreen Scrub and Treeveld	Coastal Evergreen Bush	★	COASTAL TROPICAL FOREST TYPES Coastal Forest and Thornveld	COAST VEGETATION Coast Lowlands Coast Lowlands Forest; Coast Thorn Scrub
MIDLAND OR CENTRAL SAVANNA	MIDLAND Midland Bush (1913) and Eastern Grassveld, High Veld type (1918) (See below also)	Subtropical Evergreen and Deciduous Tree and Thorn Forest (small area) and Tall Grass (incl. Acacia trees, Thorn Bush and arborescent succulents in sheltered and drier valleys)	Temperate Savanna (incl. Warm Temperate Forest) and Low Veld (small) area	MIDLAND Evergreen Subtropical Forest (Midland Postclimax) & Midland Grassland (Postclimax) (See below also)	Open Bush, Sandy		Ngongoni Veld	Coast Hinterland Semi-Coast Forest; Bush Clump-Grassland; Secondary Aristida junciformis Grassland
	Thornveld (Acacia veld) & Succulent & Thorny or Semi Karroid Scrub (1916)			Deciduous Short Tree Savanna (incl. small area of Deciduous Tall Tree Savanna)	Dry Thorn or Bushveld	Semi-Deciduous Bush (comprises part of interior Tugela Valley)	KARROID BUSHVELD TYPES Valley Bushveld	SAVANNA VEGETATION (incl. Dry Grasslands) Valley Succulent & Dry Scrub & Savanna; Thornveld
	Eastern Grassveld, Low Veld type (1918)		Grassland (incl. patches of Temperate Forest & in part Warm Temperate Forest, Moist Grassland, Protea Grassland, Montane Tussock Grassland, etc.)	★	Tall Grassveld	Ecotonal Grassland	FALSE GRASSVELD TYPES Southern Tall Grassveld	Interior Basins Themeda-Hyparrhenia Grassland
					Sandy Sourveld	★	Natal Sour Sandveld	Tristachya-Digitaria Grassland
	Midland Bush (1913) Eastern Grassveld, High Veld type (1918)			Evergreen Subtropical Forest (Midland Postclimax and Midland Grassland (Postclimax) (See above also)	Temperate Forest		TEMPERATE & TRANSITIONAL FOREST AND SCRUB TYPES Ngongoni Veld of Natal Mist Belt	UPLANDS VEGETATION Midland Mist Belt Mist Belt Mixed Podocarpus Forest & Secondary Aristida junciformis Grassland
MOUNTAIN OR UPLANDS Lower Mountain	MOUNTAIN Mountain Bush (1917); Eastern Grassland, High Veld type (1918) Tussock Veld (in part) (1917)			★	Highland Sourveld	Evergreen Mountain Forest; Protea Open Woodland and Grassland	Highland Sourveld	Highlands Mountain Podocarpus Forest; Themeda-Trachypogon Grassland; Protea Savanna
Upper Subalpine	Alpine or Subalpine (1916) Tussock Veld (1917)	Short Grass			Bergveld	Alpine	PURE GRASSVELD TYPES Themeda-Festuca Alpine Veld	MONTANE VEGETATION Mountain Region Subalpine Belt; Alpine Belt

★ Vegetation in these areas were not considered by the authors concerned

A. COAST VEGETATION

1. Coast Lowlands Region

Extent: 60 square miles
Altitude: 0 to 1,500 ft
Geology: Recent Sands, Dwyka, Ecca, Table Mountain, Dolerite
Topography: Undulating
Climate: Warm, humid; temperature extremes 45·6° C and 3·9° C; mean annual rainfall 1,001 to 1,250 mm.
Soils: Partly leached; red and greybrown fersiallitic; solodised-solonetzic; claypan; vertisols; weakly developed soils on loose sediments
Vegetation: Coast Lowlands Forest; Coast *Acacia karroo-A. nilotica-A. robusta* Thorn Scrub
Effects of man: Intensive sugar cultivation; little natural vegetation

2. Coast Hinterland Region

Extent: 360 square miles
Altitude: 1,500 to 3,500 ft
Geology: Dolerite, Ecca, Dwyka, Table Mountain, Archaean Granite and Metamorphic formations
Topography: Mainly steep
Climate: Warm, humid, transitional; temperature extremes of 41·7° C and 2·3° C; mean annual rainfall 801 to 1,250 mm.; misty precipitation
Soils: Partly leached to leached; red and greybrown fersiallitic to ferralitic
Vegetation: Semi-coast Forest; Semi-coast Bush Clump-Grassland Mosaic; Secondary *Aristida junciformis* Grassland
Effects of man: Forest decrease; secondary grassland throughout; locally severe

B. SAVANNA (including Dry Grasslands)

3. Valley Region

Extent: 2,920 square miles, including 1,700 square miles of largely secondary Thorn Veld of Interior Basins Region
Altitude: 300 ft lowest to 4,000 ft on flanks
Geology: Archaean Granite and Metamorphic formations and Table Mountain in Lower Valley Sub-region; Dwyka, Ecca and Dolerite in Interior Valley Sub-region
Topography: Steep and rugged
Climate: Warm, dry; temperature extremes of 45·0° C, with —0·8° C in Lower Valley Sub-region and —6·7° C in Interior Valley Sub-region; mean annual rainfall 601 to ?1,000 mm.; large local climatic variations
Soils: Unleached, base saturated; reddish brown and greybrown semi-arid soils, skeletal types abundant; Secondary Thorn Veld on partly leached soils (see Interior Basins Region)
Vegetation: *Spirostachys-Acacia burkei* Woodland; *Spirostachys* Valley Woodland; *Euphorbia tirucalli* Succulent Scrub; *Combretum apiculatum* Tree Veld; Semi-deciduous Bush; *Sclerocarya-Acacia* Tree Veld; Dry Coast *Acacia karroo-A. nilotica* Thorn Veld; Interior *Acacia karroo-A. nilotica* Thorn Veld
Effects of man: Severe soil erosion and destruction of vegetation; expansion of succulent and secondary tree and shrub vegetation

4. Interior Basins Region

Extent: 5,100 square miles, excluding 1,700 square miles of largely secondary Thorn Veld (see Valley Region)
Altitude: 3,000 to 4,500 ft
Geology: Ecca, Beaufort, Dolerite
Topography: Flat to undulating
Climate: Warm, dry, transitional; temperature extremes of 41·1° C, with —10·0° C in Western Sub-region and —5·6° C in small warmer Eastern Sub-region; mean annual rainfall 601 to 1,000 mm.
Soils: Partly leached; in moister areas: red and greybrown fersiallitic; ferruginous hardpan; in drier areas: claypan, solodised-solonetzic, vertisols
Vegetation: *Themeda-Hyparrhenia* Grassland (Dry and Moist Transitional Faciations); *Tristachya-Digitaria* Grassland (Dry and Transitional Faciations)
Effects of man: Slight to moderate in Transitional Faciations; moderate to severe in Dry Faciations where extensive, severe secondary encroachment by *Acacia karroo-A. nilotica* Thorn Veld

C. UPLANDS VEGETATION

5. Midland Mist Belt Region

Extent: 170 square miles
Altitude: 3,500 to 4,500 ft
Geology: Ecca, Dolerite
Topography: Mainly steep
Climate: Cool, humid; temperature extremes of [illegible] and —2·1° C; mean annual rainfall 80[illegible] abundant misty precipitation
Soils: Leached; red and greybrown ferralitic

Vegetation: Mist Belt Mixed *Podocarpus* Forest; Secondary *Aristida junciformis* Grassland
Effects of man: Forest decrease, secondary grassland throughout

6. Highlands Region

Extent: 2,180 square miles
Altitude: 4,500 to 6,500 ft
Geology: Ecca, Beaufort, Lower Stormberg, Dolerite
Topography: Undulating to steep
Climate: Cool, humid; temperature extremes of 35·0° C (38·9° C) and —13·3° C; mean annual rainfall 701 to 1,500 mm.; misty
Soils: Leached; red and greybrown ferralitic
Vegetation: Mountain *Podocarpus* Forest; *Themeda-Trachypogon* Highlands Grassland; *Themeda-Tristachya-Digitaria* Northern Highlands Grassland; *Protea* Savanna
Effects of man: Forest decrease, slight to moderate locally, increasing

D. MOUNTAIN VEGETATION

7. Mountain Region

Extent: 410 square miles
Altitude: 6,500 to *c.* 11,000 ft
Geology: Stormberg basalts
Topography: Steep and rugged
Climate: Cool, humid, montane; severe frosts, frozen soils; snow annually; mean annual rainfall 1,500 to 2,000 mm.
Soils: Leached
Vegetation: Subalpine Fynbos and *Themeda-Festuca* Grassland, Alpine Fynbos and *Danthonia-Festuca-Pentaschistis* Grassland
Effects of man: Conserved Area

CHAPTER 11

PRACTICAL IMPLICATIONS

This survey is of practical importance not only because of the uses to which the vegetation itself can be put, but also because vegetation is an indicator of the biological potential of the environment. The distribution of the principal plant communities has been mapped and the communities described; the effects of factors of climate, soils, fire, animals and man have been studied, and the status and dynamic relations of the communities established. For land use purposes the survey thus provides an inventory of basic ecological information.

11.1 Man's Influences upon the Vegetation

A fundamental principle of every land use policy should be that the land should remain permanently productive. A major practical implication of the ecological survey is that depletion of soil and vegetation resources is taking place throughout the Tugela Basin, with the possible exceptions of the Mountain Region and a few other small areas. This destruction of natural resources is evident in the soil erosion and mutilation of vegetation in approximately 1,000 square miles of the Valley Region; in over 1,500 square miles of scrub encroachment by *Acacia karroo-A. nilotica* Thorn Veld into former grassland areas; and in about 500 square miles in which a pastorally valueless grass, *Aristida junciformis* (Ngongoni) has replaced *Themeda triandra* (Red Grass). A study of the historical background of the Tugela Basin and of old photographs, the testimony of old residents and the writings of botanists in the early quarter of this century and latter part of the last century, all indicate that most of the deterioration has occurred within the last hundred years (Chapter 4, 5, 7 and 8).

There are also other significant changes in the vegetation. All the climax forests show evidence of shrinkage, and many have disappeared. Because of continuous selective grazing there has been a widespread decrease in *Themeda triandra* and other palatable components of the grasslands. The grasslands are becoming dominated by pastorally inferior *Aristida spp.*, *Eragrostis spp.*, *Elyonurus argenteus* and *Sporobolus spp.*; undesirable weeds and forbs, such as *Senecio spp.* and *Berkheya spp.*, are increasing. Throughout the grasslands, breaks in the grass cover are continually being formed and erosion is increasing. A most important feature of such changes is the migration of vegetation outwards from drier into moister areas. For example, in the driest parts of the Valley Region, succulent scrub is expanding and replacing the original deciduous and evergreen tree and shrub communities, and the tree and shrub communities in turn are expanding into areas of the moister, marginal *Acacia karroo-A. nilotica* Thorn Veld. This Thorn Veld has extended over large areas of former *Themeda-Hyparrhenia* Grassland, and *Hyparrhenia hirta*, a co-dominant of this Grassland, has within the last thirty years invaded large areas of grassland in the moister Highlands Region.

In addition there is a spread of undesirable alien species. *Eupatorium odoratum* Scrub and *Lantana camara* Scrub are spreading in the Coast Lowlands and lower Coast Hinterland Regions; *Caesalpinia decapetala* (Mauritius Thorn) Scrub and *Cestrum laevigatum* Scrub in the Coast Hinterland Region; *Solanum mauritianum* (Bugweed) Scrub in the Semi-coast and Mist Belt Mixed *Podocarpus* Forests; *Acacia dealbata* (Silver Wattle) Scrub in the grasslands of the Interior Basins and Highlands Regions; *Rubus cuneifolius* (American Bramble) Scrub in Upland Regions; and *Ulex europeaus* (Gorse) Scrub in the lower part of the Mountain Region. Numerous other valueless exotic species are also [illegible] many as weeds along roadsides, in cultivated [illegible] other disturbed areas.

It is inevitable that utilization of [illegible] changes in the primary vegetation [illegible] that many of the changes occurring in the [illegible] are a consequence of wrong land use and [illegible] disastrous effects on the productive potential of the Basin. Although there has been marked [illegible]

in vegetation and soils on many farms and in some Bantu Areas, the survey shows that available land use knowledge is still not being applied to most of the Tugela Basin. This gap between the available knowledge and its application is permitting deterioration of the natural resources to continue. To conserve available resources it is essential that every user of the land prevent deterioration. Only by rehabilitating the vegetation cover can the loss of soil and the annual pollution of the Tugela River with up to over 12,000,000 tons of silt be prevented. By determining the nature of the retrogressive changes occurring in the vegetation, the ecological survey defines many of the problems of land use and contributes, through the study of plant successions and environmental factors, to a solution of these problems.

11.2 The Scrub Encroachment Problem

By scrub encroachment is meant the invasion by trees and shrubs of grassland, or increase in the density of trees and shrubs in a savanna. The process is of considerable importance for it reduces the amount of grass available for grazing animals and may increase soil erosion. Though commonly due to *Acacia spp.*, encroachment by many other species, such as *Rubus cuneifolius* (American Bramble) and *Acacia dealbata* (Silver Wattle), also occurs. The survey shows that scrub encroachment is increasing throughout the Tugela Basin, and will continue to do so under present systems of veld management.

Although scrub control by chemical and mechanical methods will always be invaluable, especially in clearing scrub infested areas, scrub encroachment can ultimately only be satisfactorily controlled by an understanding of the fundamental ecological causes and this survey has shown that encroachment follows deterioration of the grass cover. To prevent scrub encroachment, a basic necessity is, therefore, the maintenance of a good grass cover.

Under natural conditions, fire is an essential factor in the stabilization of the grasslands of the Tugela Basin. It is logical to conclude that fire may also be an essential factor in veld management, at least until the nature of the relationship between grass and tree or shrub vegetation is better understood. A feature of burning policy in the past has been the use of fire chiefly to stimulate fresh growth for grazing, for control of animal pests such as ticks, for fire breaks and to remove old, dead grass. But burning followed by immediate heavy grazing has been a common cause of scrub encroachment. Experimental work on the relationship between fire and scrub has been neglected, and there is little experimental evidence on the sensitivity to fire of different scrub species, on the nature and amount of grass required to prevent the encroachment of different species, or on the relationship of burning for scrub control to grazing management. This survey suggests that for some shrubs, such as *Athanasia acerosa*, burning with subsequent rotational grazing management may well provide a simple means of control. But *Acacia spp.* with deep roots and tendency to coppice are far more difficult to control by fire. An obvious but seldom practised aspect of the prevention of scrub invasion is that the initial stages are those most easily controlled; scrub once established is difficult to eradicate.

In savanna the control of trees and shrubs is more difficult than in grasslands, since trees and shrubs are already present, forming a natural component of the vegetation. Even a slight disturbance of the balance between the grasses and woody plants can favour one or the other. Utilization of a savanna by grazing animals must, therefore, be carefully controlled since deterioration in grass cover leads to rapid increase in trees and shrubs. But utilization of a mixed grass-tree community by grazing animals alone is a selective use of only part of the community. It is desirable, therefore, to find some means of utilizing the tree and shrub components as well as the grasses, in order to use the vegetation more efficiently and to retain some measure of balance between the grasses and woody plants. A study of the influences of browsing animals is thus required. Under certain conditions goats can prove invaluable in the control of scrub, and it is possible that species of antelope could be similarly useful, giving increased protein production from more efficient utilization of savanna vegetation.

From the survey it is also apparent that in the Bantu Areas and on European-owned labour-tenant farms, the large numbers of goats do prevent a most serious potential scrub development. Rehabilitation of these areas is, therefore, likely to prove difficult, since an overall reduction in stock numbers is necessary to re-establish grass, and this will lead at first to dense scrub formation.

11.3 Inferences from Study of Climatic Factors

Climatic studies are important for agriculture and for certain types of industry. The peculiarities of climate may be important in the matter of industrial smogs.

In this survey data are given of sunshine duration, rainfall, relative humidity, hail, the means and extremes

of temperature, and the coincidence of temperature maxima and minima with those of rainfall. The climatic suitability of particular areas for certain crops can thus be ascertained. The differing climatic conditions in the Tugela Basin provide the basis for a diversification of crop production and hence contribute to a self-supporting economy.

For plants and agriculture generally drought is a constant menace. For the Tugela Basin the severity and duration of the dry season differs between different ecological regions, as does also the probability of drought at other times of the year. The frequency with which the rainfall is below certain amounts in any particular month of the year has been determined, and this information can now be applied to crop production. If the monthly rainfall requirements of particular crops are known, the frequency of dry months will indicate the probable frequency of crop failures. Such monthly rainfall data are valuable also for veld management when, as for rotational grazing systems, it is desirable to know the probability of a certain minimum rainfall in a particular month. For a policy of veld burning after the first spring rains of 10 mm.* in 24 hours, the rainfall data show that this is only possible a month later in the Savanna Regions than in the Coast, Uplands and Montane Regions of the Tugela Basin. In parts of the Midland Mist Belt and Coast Lowlands Regions, veld burning could be one to two months earlier than in the Highlands Region.

While the probability of frost occurrence has not been worked out owing to lack of data, this probability can be determined with considerable certainty because of the sensitivity of certain plants and plant communities to frost (see Coast Vegetation and Valley Vegetation). Determinations on this basis indicate that sugar and other subtropical crops could profitably be grown over much of the Coast Hinterland Region. This is confirmed by the increasing sugar production in similar areas of the Pietermaritzburg and New Hanover districts.

This study of the climate also indicates the importance of temperature inversions. These inversions occur throughout the Tugela catchment, being particularly strong in certain areas, such as the Valley Region where the distribution of *Spirostachys* Valley Woodland provides a useful indicator of marked temperature inversions. The absence of certain plants such as *Erythrina lysistemon*, *Euphorbia ingens* and the Coast Index species (see section 4), also indicates local frost occurrence due to cold air drainage. The inversions are important for agriculture since differences in frost incidence can be of considerable importance for determining the time of planting and suitability of different crops. But inversions have also assumed importance recently with the awareness that they prevent the dissipation of atmospheric effluents, creating a smog environment detrimental to human, plant and animal welfare. Although atmospheric effluent discharges can be avoided or reduced by various means, it is unlikely, for some time at least, that they can be eliminated. Local climatic studies thus appear to be of major importance in order to prevent the creation of artificial atmospheric environments through the injudicious location of industry in relation to local topography and local climatic phenomena.

11.4 Major Land Use Features and Indicator Plants

One of the chief results emerging from the ecological survey has been the delimitation of the Tugela Basin into seven main ecological or natural regions, in each of which there are basic similarities of physiography, climate, soils and vegetation (Fig. 4). Since the delimitations are the result of the integration of a number of factors fundamental to considerations of correct land use, they are of particular significance for the regional assessment of productive potential and for the overall developmental planning of the Basin.

The twenty-four principal plant communities shown on the map can be correlated with climatic and soil conditions in the regions. In addition to these are many minor communities indicative of local special conditions or resulting from disturbance by man. These communities have not been mapped, but are discussed in the text. Attention is drawn to the indicator value of some of these and the principal communities below.

A. COAST REGIONS

Index plants are *Trichilia emetica*, *Croton sylvaticus*, *Rauvolfia caffra*, *Syzygium cordatum*, *Protorhus longifolius*, *Trema orientalis* and *Albizia adianthifolia*. Climates are warm and humid. Soils are leached or partly leached. Regions are suitable for intensive agriculture.

(a) COAST LOWLANDS REGION

Index plants are *Antidesma venosum*, *Brideli[illegible]*, *Carissa macrocarpa*, *Millettia grandis*, *Hyphaene* [illegible] and *Phoenix reclinata*. Climate is warm [illegible]

* Usually taken as 12·7 mm. (½ inch) in 24 hours.

little or no frost; rainfall is best distributed and most reliable in the Basin. Soils are partly leached.

(1) *Coast Dune Forest*. Index species *Mimusops caffra*. This forest indicates areas subject to severe sea spray effects and, therefore, unsuitable for afforestation or for cultivation of plants liable to salt spray damage. Sandy soils are prone to wind erosion when vegetation is removed.

(2) *Coast* Acacia karroo-A. nilotica-A. robusta *Thorn Scrub* (Map 1). Index species are *A. karroo*, *A. nilotica* and *A. robusta*, together with index plants of Coast Lowlands and Coast Regions. This is an area of high atmospheric humidities and little or no frost. The area is suitable for sugar cultivation, for other subtropical crops, for dairying from cultivated pastures, or for afforestation.

(B) COAST HINTERLAND REGION

Index plants are *Maesa lanceolata*, *Cyathea dregei* and *Stoebe vulgaris*, together with Coast Index plants. Climate is warm, humid, transitional, with light frost. Soils are leached or partly leached.

(1) *Semi-coast Bush Clump-Grassland Mosaic* (Map 1). Index plants are *Cussonia spicata* and *Ficus petersii* in bush clumps scattered in *Aristida junciformis* grassland. Community indicates warmer and less misty climate than following community (2), and mainly partly leached soils. Area suitable for sugar farming and cultivation of other subtropical crops where land is flat, and for afforestation if precautions are taken on steep slopes. Severe erosion may occur from cultivation on steep slopes.

(2) *Semi-coast Secondary* Aristida junciformis *Grassland* (Map 1). Index community, *Aristida junciformis* Grassland, together with Coast Index plants. Area has a misty climate, leached soils and veld of poor pastoral value. Afforestation possible provided that erosion can be prevented on steep slopes and that access can be gained to some areas. Where land is cultivable, frost sensitive plants, tolerant of or requiring misty conditions, can be grown.

B. SAVANNA REGIONS

Index plants are *Boscia albitrunca*, *Combretum apiculatum*, *Acacia tortilis* and *Euphorbia spp.* (all in driest areas with unleached arid soils). Index communities are *Acacia karroo-A. nilotica* Thorn Veld, *Acacia caffra* Scrub and Tree Veld and *Acacia sieberiana* Tree Veld (all in moister areas with partly leached soils). Climates are warm and dry. Soils are unleached or partly leached. Regions are suitable chiefly for extensive and semi-intensive farming.

(C) VALLEY REGION

Index plants are *Boscia albitrunca*, *Combretum apiculatum*, *Acacia tortilis*, *Spirostachys africana* and *Euphorbia spp.* Index communities of marginal Valley Region are Dry Coast and Interior *Acacia karroo-A. nilotica* Thorn Veld. Topography is rugged and climate is warm and dry with no to severe frost. Unleached arid soils in driest areas, and claypan and vertisol soils in marginal Valley Region. Region suitable chiefly for extensive farming.

(1) Spirostachys-Acacia burkei *Woodland* (Map 1). Index plant *Acacia burkei*. Indicative of hot, frost free, and relatively moister, eastern part of Valley Region with dense Valley mists. *Acacia burkei* Consociation indicates sandy soils on flatter lands, where some intensification of farming is possible and sugar cane can be grown. *Spirostachys* Consociation is a dense community on steep and stony Valley sides where extensive grazing is limited.

(2) Spirostachys *Valley Woodland* (Map 1). Index plants *Spirostachys africana*, *Acacia robusta* and *Acacia tortilis*. Indicates hot, dry areas with dense valley mists, and deep soils along bottom of Valley Region. Areas are highly productive under irrigation. Because of extremely severe disturbance only remnants of the community are found.

(3) Combretum apiculatum *Tree Veld* (Map 1). Index plant *Combretum apiculatum*. Indicative of steep and stony dry hill slopes. Suitable only for extensive grazing.

(4) *Semi-deciduous Bush* (Map 1). Index plants *Acacia tortilis*, *Boscia albitrunca*, *Olea africana*, *Schotia brachypetala* and *Euclea schimperi*. Moderately severe to severe frosts occur on deep soils along bottoms of valleys where cultivation is highly productive under irrigation. Dense scrub on stony hillsides provides a limited amount of grazing.

(5) Euphorbia tirucalli *Succulent Scrub* (Map 1). Index plant *Euphorbia tirucalli*. An economically valueless community which needs to be cleared since it is invading other vegetation and assuming the rôle of a climax vegetation.

(6) Sclerocarya-Acacia *Tree Veld* (Map 1). Index plants *Sclerocarya birrea* and *Acacia nilotica*. Shows areas of relatively deep soils and softly weathering rocks on fairly even topography. Although overgrazed there is relatively little deterioration. If water could be made

Photo. 80. As in Photo. 79, right side of fence, recently autumn burnt Moist Transitional *Themeda-Hyparrhenia* Grassland. Note tufted character of the grassland, with poor basal cover, not significantly different from that in the adjoining, continuously overgrazed Bantu area (Photo. 79). The newly exposed soil surface is crumbly and easily eroded, and will remain thus, largely bare, through winter to spring. The treatment of a long rest, followed by an autumn fire, is from aspects of plant cover and effects on species composition as bad as continuous overgrazing.

Photo. 81. General view of *Tristachya-Digitaria* Grassland with termitaria, on flat topography. Early summer aspect with flowering culms of *Elyonurus argenteus* and local stand of *Themeda triandra*. Interior Basins Region, Utrecht area.

Photo. 82. Local *Monocymbium ceresiiforme* autumnal aspect in *Tristachya-Digitaria* Grassland. Newcastle-Utrecht road. 22/5/62.

Photo. 83. Selective grazing in *Tristachya-Digitaria* Grassland, leaving large tufts of *Aristida junciformis* and small tufts of *Elyonurus argenteus*. Grassland composition is thus changed to a secondary *A. junciformis* or *E. argenteus* Grassland. Newcastle-Utrecht road. 22/5/62.

Photo. 84. Secondary *Elyonurus argenteus* Grassland resulting from selective grazing of *Tristachya-Digitaria* Grassland. Newcastle-Utrecht road. 22/5/62.

Photo. 85. Overgrazed and trampled *Tristachya-Digitaria* Grassland. Showing tufts of secondary *Eragrostis sp.* (=DE 1038) raised several inches above eroding soil surface. Windblown sand collecting in cattle hoof marks on heavily trampled, indurated soil surface. Near Dolphin-kop, off Newcastle-Utrecht road. 23/11/55.

Photo. 86. Hyparrhenia hirta Consocies on left side of fence on old land. On right side of fence a secondary mixed *Elyonurus argenteus* and *Tristachya-Digitaria* Grassland, resulting from selective grazing. Newcastle-Utrecht road. 22/3/55.

Photo. 87. General view west of *Themeda-Trachypogon* Highlands Grassland on undulating topography of Southern Highlands. In distance, the High Drakensberg with Giant's Castle at left. 5,000 ft. Mooi River-Hlatikulu road. 8/12/58.

available relatively large areas may be suitable for irrigation.

(7) Euphorbia grandicornis *Scrub*. Communities of *Euphorbia grandicornis* are indicative of heavy disturbance in hot, dry areas where there is only light frost.

(8) Euphorbia pseudocactus *Scrub*. Communities of *Euphorbia pseudocactus* indicate severe disturbance in hot, dry areas where frosts are moderately severe.

(9) *Euphorbia ingens* and *Erythrina lysistemon* indicate no or only light frost.

(10) *Acacia tortilis*, *A. nilotica*, *A. karroo* and *Diclirostachys cinerea* thicket communities are indicative of old lands or areas from which vegetation was cleared.

(11) *Blepharis natalensis* Low Scrub and in field layer of other communities shows severe overgrazing in hottest and driest areas.

(12) *Dry Coast* Acacia karroo-A. nilotica *Thorn Veld* (Map 1). Index plants *Acacia karroo*, *A. nilotica*, *Aristida junciformis*. Indicates moister marginal areas of the eastern Valley Region where frosts are absent or only light. Grazing is poor because of the *Aristida junciformis* grass field layer and because of the strong tendencies to scrub formation but, where soils are suitable, greater intensification of farming is possible than in (13).

(13) *Interior* Acacia karroo-A. nilotica *Thorn Veld* (Map 1). Index plants *Acacia karroo*, *A. nilotica*, *Hyparrhenia hirta*, *Eragrostis superba*. Occurring on the margins of the western Valley Region where frosts may be severe, this community also indicates an area of extensive secondary scrub encroachment into the grasslands of the Interior Basins Region. These areas are suitable largely for extensive grazing, though some cultivation is possible on certain soils and where, if the trees are removed, flat and gently sloping land can be mowed for veld hay. Because the community indicates less valuable agricultural land, the location of industry in these areas is appropriate.

(14) *Riverine* Cynodon dactylon *Grassland* is capable of withstanding heavy grazing and indicates alluvial soils suitable for cultivation, provided that the riverbanks are adequately protected.

(15) *Reedswamp and Fringing Hygrophilous Communities and Riverine and Streambank Woodland*. Index plants *Phragmites communis*, *Cyperus spp.*, *Salix woodii*, *Ficus capraefolia*, *F. sycamorus*, *Combretum erythrophyllum*. Vegetation that should be conserved in order to stabilize the banks of rivers and streams.

(16) *Semi-coast and Interior Mesophytic Kloof and Rocky Hillside Scrub and Scrub-forest*. Index plants *Cussonia spicata*, *Heteropyxis natalensis*, *Acacia caffra*, *Rhus relhmanniana*, *Commiphora harveyana*, *Pachystigma macrocalyx*. Vegetation that can be conserved to provide a habitat for game birds and animals and which can, therefore, provide sport for the hunter or relaxation for the naturalist and nature lover.

(D) INTERIOR BASINS REGION

Index communities are *Acacia sieberiana* Tree Veld, Interior *Acacia karroo-A. nilotica* Thorn Veld, Interior *Acacia caffra* Scrub and Tree Veld, *Diospyros lycioides* Scrub, *Themeda-Hyparrhenia* Grassland and *Tristachya-Digitaria* Grassland. Climate is warm, relatively dry, transitional to Highlands Region. Topography is even with claypan and vertisol soils in the driest areas and fersiallitic soils in the moister areas. Potential farming systems range from semi-intensive to intensive.

(1) *Dry* Themeda-Hyparrhenia *Grassland* (Map 1), to which should also be added most of the area now covered by the Interior *Acacia karroo-A. nilotica* Thorn Veld (Map 1). Index plants *Hyparrhenia hirta*, *Cymbopogon plurinodis*, *Setaria woodii*, *Eragrostis superba*, *Bothriochloa insculpta*. Shows relatively dry areas, largely with erodible soils, so that farming systems are potentially mainly semi-intensive. The Grassland also indicates areas prone to *Acacia karroo-A. nilotica* scrub encroachment. Industrial development is desirable in these less valuable agricultural areas rather than in the following.

(2) *Moist Transitional* Themeda-Hyparrhenia *Grassland* (Map 1). Index plants *Andropogon filifolius*, *Cymbopogon excavatus*, *Monocymbium ceresiiforme*, *Hyparrhenia hirta*. Indicates some of the most valuable agricultural land. Much of it has been subjected to little disturbance. On the even topography, with deep and well drained soils and relatively moist climate, there is scope for intensification of farming activity. Afforestation is also possible (see following).

(3) *Transitional* Tristachya-Digitaria *Grassland* (Map 1). Index plants *Digitaria tricholaenoides*, *Alloteropsis semialata*, *Andropogon amplectens*, *A. appendiculatus*, *Themeda triandra*. Indicates land capability [illegible] similar to those of the Moist Transitional [illegible] *Hyparrhenia* Grassland, but the veld is [illegible] grazing. Afforestation could, therefore, [illegible] rôle than in Moist Transitional *Themeda* Grassland, but hail is detrimental to [illegible] other crops in certain parts of both the grassland [illegible]

(4) Tristachya-Digitaria *Grassland* (Map 1), [illegible] plants *Digitaria tricholaenoides*, *Elyonurus argenteus*

Eragrostis gummiflua, *Pogonarthria squarrosa*, *Aristida junciformis*, *Andropogon eucomus*. Shows a difficult farming area, with relatively dry climate. Soils are poor in nutrients, often badly drained and prone to wind erosion. The vegetation provides inferior grazing. Because of the even topography and because moisture relations on deep sandy soils are better than on heavier soils under similar climatic conditions, and if the physico-chemical problems of the soils can be overcome, there may be a considerable productive potential for the area covered by this Grassland.

(5) *Andropogon eucomus* commonly shows areas of poor soil drainage and ferruginous hardpan ('Ouklip').

(6) *Aristida junciformis* Grassland shows poor veld management and commonly indicates autumn burning practices in the Interior Basins Region.

(7) *Elyonurus argenteus* Grassland shows selective grazing arising from continuous grazing practices, commonly on sheep farms.

(8) *Hyparrhenia hirta* Grassland in pure stands commonly indicates old cultivation and old heavily disturbed areas.

(9) *Eragrostis plana-Sporobolus pyramidalis* Grassland indicates heavily grazed and heavily manured areas, old cultivation and disturbed areas.

(10) An abundance of annual weeds, *Senecio spp.*, *Berkheya spp.*, and of forbs in a heavily grazed grassland dominated by *Aristida spp.*, *Eragrostis spp.*, or *Sporobolus spp.*, indicates a grassland close to breakdown.

(11) *Aster filifolius* Scrub shows a former grassland broken down by overgrazing.

(12) *Digitaria monodactyla*, *Microchloa caffra*, *Rendlia altera*, *Eragrostis racemosa* and *E. capensis* Grasslands commonly indicate shallow soils.

(13) *Pycreus macranthus-Fimbristylis complanata-Fuirena pubescens* Sedge Meadow *and Agrostis huttoniae/A. lachnantha-Eragrostis nebulosa/E. planiculmis* Hygrophilous Grass Meadow indicate moist areas often suitable for cultivation.

C. UPLANDS REGIONS

Index plants are *Leucosidea sericea* and *Buddleia salviifolia*; absent are *Acacia spp.* and Coast Index plants. Climates are cool and humid. Soils are leached. Regions are suitable for intensive agriculture.

(E) MIDLAND MIST BELT REGION

Index community is Mist Belt Mixed *Podocarpus* Forest, in which Coast Index plants are absent, but present are *Combretum kraussii* and *Xymalos monospora*. Climate is cool, humid and misty with only moderately severe frosts.

(1) *Mist Belt Secondary* Aristida junciformis *Grassland* (Map 1). Index plant *Aristida junciformis*, together with plant and community indices of Mist Belt Region. Grassland of low pastoral value. Prospects for afforestation are excellent provided that precautions are taken to prevent erosion on steep slopes. It is possible that other crops tolerant of a certain amount of frost and requiring considerable misty precipitation would provide a higher economic return.

(2) *Mist Belt Mixed* Podocarpus *Forest* (Map 1). Index plants *Combretum kraussii* and *Xymalos monospora* with no Coast Index species. These tall forests reflect the excellent growth of trees, but the forests themselves are unique, conserve water resources, and thus deserve protection and only light utilization.

(F) HIGHLANDS REGION

Index community is Mountain *Podocarpus* Forest and index plants are *Olinia emarginata* and *Protea rouppelliae*. Climate is cool and humid with severe frosts.

(1) Themeda-Trachypogon *Highlands Grassland* (Map 1). Index plants *Themeda triandra*, *Trachypogon spicatus*, *Monocymbium ceresiiforme*, *Andropogon filifolius*, *Alloteropsis semialata*, *Buddleia salviifolia*, *Leucosidea sericea*. Indicates areas where, depending on topography and soils, there is a high potential for afforestation and intensive agriculture. Flat and undulating land occurs mainly in the Southern Highlands, the remaining steeper areas being suitable chiefly for afforestation.

(2) Themeda-Tristachya-Digitaria *Northern Highlands Grassland* (Map 1). Index plants *Digitaria tricholaenoides*, *Aristida junciformis*, *Elyonurus argenteus*, *Leucosidea sericea*. Indicates drier areas than (1) with less favourable soils where the degree of intensification of farming is less.

(3) *Aristida junciformis* Grassland in the Highlands Region is indicative of grazing conditions causing deterioration of the veld.

(4) *Hyparrhenia hirta* encroachment into the Highlands Region is indicative of an increasing grassland utilization but the species may give better grazing than the primary grassland.

(5) *Athanasia acerosa* encroachment into grassland commonly indicates close grazing and overgrazing.

(6) *Mountain* Podocarpus *Forest* (Map 1). Index plants

Podocarpus latifolius, *Rapanea melanophloeos*, *Olinia emarginata*, *Halleria lucida*. Indicates patches of vegetation deserving of conservation for protection of water resources, for the maintenance of habitats for birds and other animals, and for recreation.

(7) *Forest Margin and Precursor Scrub*. Index plants *Buddleia salviifolia*, *Leucosidea sericea*, *Artemisia afra*, *Pteridium aquilinum*, *Miscanthidium capense*. Indicates vegetation which, if protected, will ultimately develop into Mountain *Podocarpus* Forest.

(8) Protea *Savanna* (Map 1). Index plants *Protea multibracteata*, *P. rouppelliae*. Along the Drakensberg indicates steep, high rainfall country which, with the Mountain Region (see (G)), is most suitable for use as a conservation area.

(9) See also section (D), paragraphs (5) to (13).

D. MONTANE REGIONS

(G) MOUNTAIN REGION

Index plants are *Festuca caprina*, *Danthonia drakensbergensis*, *D. stereophylla*, various *Erica spp.* and *Helichrysum spp.* (Chapter 9). Climate is cool, humid, montane. Because of its major contribution to the water resources of the Tugela Basin, conservation of the Mountain Region (and the *Protea* Savanna) must be regarded as essential. With its spectacular scenery the Region can serve also as a major unspoiled area for recreation by future populations.

(1) *Subalpine* Themeda-Festuca *Grassland*. Index plants *Themeda triandra*, *Festuca costata*, *Koeleria cristata*, *Stiberus alopecuroides*, *Andropogon filifolius*. Indicates the chief grassland of warmer, lower altitudes, which can be utilized for grazing animals if carefully managed on the steep slopes. In conserved areas utilization would be mainly by antelope.

(2) *Alpine* Danthonia-Festuca-Pentaschistis *Grassland*. Index plants *Danthonia disticha*, *Festuca*, *caprina*, *Pentaschistis oreodoxa*. Indicates the chief grassland of grazing value on the coldest and highest summit areas where topography is less of a limiting factor for utilization than on the escarpment slopes.

E. CONCLUSIONS

(1) Intensive farming, based on cultivated crops, dairying or meat production from planted pastures, or on afforestation, could be developed in the Coast, Uplands and moister parts of the Interior Basins Regions, which comprise approximately 4,360 square miles, or 40% of the Tugela Basin. At present, intensive agriculture is highly developed only in the Coast Lowlands Region, which covers less than 1% of the Basin. There is thus a large undeveloped potential for the most highly productive forms of agriculture and afforestation.

(2) Areas suited to semi-intensive farming, based on extensive grazing and some cultivation, cover approximately 5,130 square miles, or 46% of the Tugela Basin. These areas occur chiefly in the drier marginal parts of the Interior Basins Region and on steep lands in the moister Coast and Uplands Regions. In these areas there are over 1,500 square miles of secondary *Acacia karroo A. nilotica* Thorn Veld in which scrub formation seriously limits full agricultural utilization.

Industrial development in the drier parts of the semi-intensive farming areas appears highly desirable because of the geographical situation of these areas in relation to labour resources (see also (3)), communications and water, and because of their unsuitability for intensive food production or afforestation.

(3) Extensive farming areas, based on veld grazing, cover approximately 940 square miles, or 8% of the Tugela Basin. They comprise the Succulent and Dry Valley Scrub and Savanna where the climate and steep topography limit cultivation. Although the primary grass cover is highly palatable and nutritious throughout the year, productivity is at present low because of the extremely serious deterioration of veld and soil resources. Extensive reclamation is necessary to prevent further erosion and to restore the former grass cover. The development of industry on the borders of the Bantu Areas of the Valley Region (see also (2)), in which most of the deterioration has occurred, would assist in the institution of essential reclamation measures. Although potentially irrigable areas in the Bantu Reserves are limited, they may contribute significantly to the local economy

(4) The most appropriate form of land use for the High Drakensberg, covering about 790 square [illegible] 7% of the Tugela Basin, is as a conserved [illegible] tect the main watershed of the Basin and to [illegible] future urban populations have at [illegible] unspoiled area for recreational purposes

APPENDIX 1

CLIMATE

Table A1. Duration and percentage of possible sunshine (1951–1955)

Station		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Durban	hours	6·0	6·8	6·5	7·2	7·3	7·9	7·9	7·0	6·5	5·2	5·5	5·3	6·6
	%	43	51	53	63	69	78	75	64	55	41	40	38	56
Estcourt	hours	6·5	6·4	7·0	7·8	7·8	8·8	8·6	8·3	8·2	6·7	6·7	6·4	7·4
	%	47	49	57	68	74	86	82	76	67	51	49	46	61
Cathedral	hours	5·1	5·4	5·9	7·1	7·6	8·6	8·3	8·2	8·1	6·4	6·0	5·5	6·6
Peak	%	37	41	48	62	71	83	79	74	68	50	44	39	57

Durban —Included for comparison and as representative of Coast Lowlands
Estcourt —Marginal Interior Basins
Cathedral Peak —Upper Highlands

Table A2. Mean cloud amount (0–10)

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Coast Lowlands														
Durban ..	a.m.	6·1	5·4	4·9	4·2	3·3	2·7	2·5	3·7	4·9	6·3	6·1	6·0	4·7
	p.m.	5·9	5·4	4·9	4·2	3·4	2·5	2·5	3·2	4·6	6·5	6·5	6·3	4·7
Valley														
Mfongosi* ..	a.m.	6·6	6·0	5·3	3·9	3·0	2·4	3·0	3·4	4·7	6·4	6·5	6·6	4·8
	p.m.	—	—	—	—	—	—	—	—	—	—	—	—	—
Interior Basins														
Estcourt ..	a.m.	5·5	5·2	5·0	3·8	2·7	2·2	2·4	2·8	3·5	4·8	5·4	5·3	4·1
	p.m.	6·0	5·5	5·5	3·7	2·8	2·3	1·8	2·5	3·3	5·4	5·7	5·8	4·2
Ladysmith ..	a.m.	5·3	4·9	5·2	4·2	2·5	1·6	2·5	3·1	3·5	5·0	4·9	4·6	3·9
	p.m.	5·1	4·5	4·7	3·1	2·0	1·4	1·4	1·7	2·9	4·7	4·9	4·8	3·4
Dundee ..	a.m.	5·6	5·6	5·5	4·3	3·0	2·5	2·6	3·2	3·8	5·3	5·8	5·7	4·4
	p.m.	6·3	6·1	6·0	4·6	3·1	2·6	2·4	2·2	4·0	5·7	6·7	6·3	4·7
Newcastle ..	a.m.	5·7	5·7	5·1	3·8	2·7	2·1	2·2	2·5	3·5	4·5	5·3	5·1	4·0
	p.m.	5·2	5·6	4·7	3·3	2·2	1·8	1·7	1·8	3·1	4·3	5·2	5·1	3·7
Highlands														
Nottingham Road ..	a.m.	5·7	5·3	5·4	3·9	3·0	2·3	2·5	3·4	4·1	5·5	5·8	5·7	4·4
	p.m.	—	—	—	—	—	—	—	—	—	—	—	—	—
Cathedral Peak	a.m.	6·5	6·2	5·3	3·8	3·1	1·8	2·1	3·1	3·4	5·9	6·3	6·0	4·1
	p.m.	—	—	—	—	—	—	—	—	—	—	—	—	—
Wakkerstroom	a.m.	5·7	5·5	5·1	3·8	2·3	2·0	1·9	2·4	3·2	4·6	5·4	5·3	3·9
	p.m.	6·0	6·5	5·6	4·3	2·8	2·0	1·7	3·0	4·1	5·2	6·2	6·4	4·5

a.m.—Readings at 0800 hours p.m.—Readings at 1400 hours *—Readings at 0830 hours

Table A3. Months with maximum temperatures above specified limits

	Mean daily maximum		Mean highest monthly	
	⩾30°C	⩾25°C	⩾30°C	⩾25°C
Coast Lowlands				
Amatikulu	January and February (2)	August to May (10)	Whole Year (12)	Whole Year (12)
Stanger	—	September to May (9)	Whole Year (12)	Whole Year (12)
Coast Hinterland				
Eshowe	—	November to April (6)	August to April (9)	Whole Year (12)
Valley				
Mfongosi	December and January (2)	September to April (8)	August to May (10)	Whole Year (12)
Nietgedacht ..	December and January (2)	September to April (8)	August to April (9)	Whole Year (12)
Weenen	December to February (3)	September to April (8)	August to April (9)	Whole Year (12)
Interior Basins				
Vryheid	—	October to March (6)	September to February (6)	Whole Year (12)
Ladysmith	—	September to April (8)	August to April (9)	Whole Year (12)
Colenso	January (1)	September to April (8)	September to April (8)	Whole Year (12)
Estcourt	—	October to March (6)	September to March (7)	August to May (10)
Dundee	—	October to March (6)	September to March (7)	July to May (11)
Newcastle	—	September to April (8)	September to April (8)	Whole Year (12)
Midland Mist Belt				
Greytown	—	December to February (3)	September to March (7)	August to May (10)
Highlands				
Cathkin Park ..	—	October to March (6)	September to March (7)	August to June (11)
Cathedral Peak ..	—	—	—	September to March (7)
Nottingham Road..	—	—	October to January (4)	August to April (8)
Volksrust	—	—	October (1)	Septem...
Wakkerstroom ..	—	—	October (1)	...

Table A4. Mean daily maximum and mean highest monthly temperatures (°C)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Coast Lowlands												
Amatikulu ..	30·2	30·7	29·8	27·6	26·0	24·1	23·7	25·0	26·1	27·2	28·4	29·7
	39·6	37·8	36·6	33·7	31·8	30·2	30·7	34·9	36·8	38·5	38·6	39·0
Stanger ..	28·2	29·3	28·5	27·4	25·3	24·0	23·4	24·8	25·5	26·6	27·0	28·3
	36·1	35·6	35·5	33·8	31·2	31·1	30·6	32·8	34·9	37·4	36·6	36·6
Coast Hinterland												
Eshowe ..	26·8	27·1	26·2	25·1	23·3	21·6	21·2	22·5	23·4	24·4	25·3	26·1
	35·1	33·4	33·1	30·8	29·3	27·7	28·3	31·5	33·4	35·2	34·4	34·3
Valley												
Mfongosi ..	30·4	29·6	29·1	27·8	24·0	20·9	21·2	24·5	27·0	28·2	29·2	30·2
	39·7	37·9	37·3	35·0	31·6	28·9	29·2	32·6	38·1	39·7	40·1	40·7
Nietgedacht ..	30·9	29·8	28·7	26·9	24·2	21·3	20·6	23·8	25·8	28·0	28·8	30·0
	37·6	35·6	35·0	31·5	29·4	26·0	27·2	30·1	34·7	37·3	37·1	37·4
Weenen ..	31·2	30·2	29·0	27·0	24·2	21·3	21·0	23·9	26·3	28·1	28·9	30·4
	38·9	37·8	35·6	34·1	29·8	27·0	26·2	31·1	34·7	37·6	37·8	38·5
Interior Basins												
Vryheid ..	27·3	27·1	25·8	24·7	21·9	20·1	19·9	22·4	24·1	25·3	26·0	27·0
	34·3	33·9	28·3	29·4	26·8	26·4	26·1	29·8	32·4	34·1	33·5	34·5
Ladysmith ..	29·6	29·2	27·5	25·9	23·0	20·7	20·9	23·8	26·4	27·3	28·8	29·7
	36·7	35·5	34·0	31·8	28·1	26·1	26·8	30·1	34·1	35·5	35·9	36·9
Colenso ..	30·4	29·6	27·7	26·3	22·9	19·9	20·2	23·6	26·1	27·7	28·4	29·9
	36·5	35·6	34·4	32·7	29·1	26·1	26·5	29·8	33·6	35·4	36·0	36·6
Estcourt ..	27·3	26·9	25·6	24·0	21·2	18·9	18·7	21·4	24·1	25·4	26·1	27·1
	34·4	32·8	31·6	29·6	26·5	23·8	24·8	27·7	32·0	33·9	34·0	34·5
Dundee ..	27·5	27·0	25·6	24·4	22·0	19·5	19·6	22·4	24·6	26·1	26·6	27·7
	33·9	32·5	31·8	29·6	27·4	24·5	25·1	28·2	32·1	34·1	33·9	34·6
Newcastle ..	28·4	27·7	26·4	25·1	22·5	20·1	20·1	23·1	25·7	27·1	27·7	28·9
	35·5	33·8	32·9	30·9	28·2	25·3	25·5	28·9	33·1	35·5	35·0	35·7
Midland Mist Belt												
Greytown ..	26·0	25·8	24·3	23·3	21·2	18·7	18·6	21·2	22·4	22·7	24·6	25·6
	33·3	31·7	30·9	28·9	27·1	24·1	24·2	28·3	31·6	33·9	33·4	33·9
Highlands												
Cathkin Park ..	27·1	26·6	25·3	23·9	21·7	19·2	19·2	21·4	23·4	25·1	25·6	26·4
	32·8	31·4	30·6	28·9	27·2	25·1	24·9	28·1	30·9	32·6	33·2	32·4
Cathedral Peak	20·8	20·7	19·9	18·9	16·4	14·6	14·3	16·4	19·2	20·3	20·2	21·1
	27·1	26·7	25·2	24·8	22·3	19·5	19·8	23·0	26·7	28·7	27·9	28·3
Nottingham Road	23·7	23·7	22·7	21·3	19·4	17·2	17·1	19·8	21·7	22·4	22·8	23·7
	30·8	29·5	28·7	26·8	24·8	22·6	23·0	26·8	29·9	31·7	31·2	31·5
Volksrust ..	24·3	23·7	22·8	21·1	18·6	16·3	15·8	18·9	21·7	22·9	22·9	24·0
	29·7	28·6	28·3	25·5	22·7	21·1	21·4	24·8	28·5	30·6	29·8	29·4
Wakkerstroom	24·5	24·0	23·2	21·5	19·0	16·4	16·4	19·1	21·4	23·1	23·0	24·4
	29·8	28·7	27·9	26·3	23·8	21·9	21·0	24·4	28·1	30·0	29·3	29·9

Mean daily maximum temperatures are given on the top line and mean highest monthly temperatures on the bottom line for each station

Table A5. Extreme maximum temperatures and number of months for which no temperatures over or equal to 35° C (95° F) ever recorded

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mths ⩽35° C
Coast Lowlands													
Stanger	42·5	41·1	38·9	38·8	36·7	33·1	33·9	38·3	40·6	43·3	41·7	**43·9**	2
Amatikulu	43·9	41·0	40·6	37·8	34·2	33·3	32·9	38·6	40·8	42·8	**45·6**	41·9	3
Coast Hinterland													
Eshowe	39·4	38·3	38·6	36·6	33·3	31·1	30·8	35·2	38·9	40·1	40·7	**41·7**	3
Valley													
Mfongosi	43·9	43·6	40·6	37·8	34·4	33·3	31·1	36·7	40·6	43·3	**45·0**	43·9	3
Nietgedacht	**41·1**	38·3	36·9	33·3	32·5	27·8	28·3	31·7	37·8	40·0	40·6	39·4	5
Weenen	42·2	40·6	37·8	40·6	35·0	31·1	28·9	34·4	38·3	**42·8**	41·1	41·7	3
Interior Basins													
Vryheid	38·4	37·2	35·0	32·6	30·0	30·0	31·7	37·2	35·0	37·8	35·3	**38·9**	4
Ladysmith	38·3	38·3	36·6	34·4	30·0	27·8	28·3	31·9	36·1	38·0	**40·0**	39·9	5
Colenso	38·9	38·3	36·7	35·0	31·7	29·4	28·3	32·8	36·1	37·8	**41·1**	39·4	4
Estcourt	**38·9**	36·7	35·0	31·9	30·0	27·2	26·7	29·4	34·4	37·8	37·8	37·2	6
Dundee	**38·9**	36·7	36·1	31·7	32·8	27·3	28·3	31·1	35·6	**38·9**	37·7	37·8	5
Newcastle	38·9	37·8	35·6	32·3	32·2	27·9	28·3	31·7	35·9	37·8	**39·6**	39·2	5
Midland Mist Belt													
Greytown	**37·9**	35·5	34·4	30·5	30·9	27·5	26·7	30·6	34·8	37·3	36·4	36·7	7
Highlands													
Cathkin Park ..	35·0	35·6	32·2	31·7	30·6	30·0	27·2	31·1	34·4	36·1	**38·9**	35·0	7
Cathedral Peak ..	28·8	30·4	25·2	25·5	25·4	20·4	21·1	26·4	27·1	29·2	**31·2**	30·2	12
Nottingham Road ..	33·3	32·8	30·0	28·3	28·3	26·1	26·1	30·6	32·2	**35·0**	33·9	34·4	11
Volksrust	31·4	30·7	31·0	27·9	24·8	24·9	23·5	27·3	30·6	**34·3**	32·7	33·2	8
Wakkerstroom ..	33·4	32·0	31·6	28·2	26·5	24·6	23·9	27·3	29·5	**33·8**	33·6	32·1	8

Table A6. Months with minimum temperatures below specified limits.

	Mean daily minimum		Mean lowest monthly	
	⩽0·0°C	0·1 to 2·8°C	⩽0·0°C	0·1 to 2·8°C
Coast Lowlands				
Amatikulu	—	—	—	—
Stanger	—	—	—	—
Coast Hinterland				
Eshowe	—	—	—	—
Valley				
Mfongosi	—	—	—	June (1)
Nietgedacht ..	—	June and July (2)	June and July (2)	May to September (5)
Weenen	—	June and July (2)	May to August (4)	May to September (5)
Interior Basins				
Vryheid	—	—	—	May to August (4)
Ladysmith	—	—	June to August (3)	May to August (4)
Colenso	—	June and July (2)	June to August (3)	May to August (4)
Estcourt	—	June and July (2)	June to August (3)	May to September (5)
Dundee	—	June and July (2)	June to August (3)	May to September (5)
Newcastle	—	June and July (2)	May to August (4)	April to September (6)
Midland Mist Belt				
Greytown	—	—	—	June to August (3)
Highlands				
Cathkin Park ..	—	July (1)	June and July (2)	May to September (5)
Cathedral Peak ..	—	—	June to August (3)	May to October (6)
Nottingham Road..	June and July (2)	May to August (4)	April to September (6)	April to October (7)
Volksrust	June and July (2)	May to August (4)	April to September (6)	April to September (6)
Wakkerstroom ..	June and July (2)	May to August (4)	April to September (6)	April to November (8)

Note: Columns 3 and 4 of the above table follow closely the tables given for first and last frost dates in the publications "Climate of S.A. Pt. 1. Climate Statistics", 1954, and "Temperature", Met. Office, 1941. Here, however, 0·0 C has been taken as indicating the heavier frosts, and less than or equal to 2·8 C as indicating light frosts.

Photo. 88. Late spring aspect of *Themeda-Trachypogon* Highlands Grassland, burnt in early spring and showing numerous forbs. Above Dundee reservoir. 5,100 ft. 26/11/55.

Photo. 89. Scilla natalensis community on steep slopes in *Protea* Savanna. Royal Natal National Park. 5,600 ft. 3/2/55.

Photo. 90. Showing thick mat of dry, dead grass in *Themeda-Trachypogon* Highlands Grassland not burnt or grazed for five years. Remaining grasses moribund. Qudeni summit. +5,000 ft. 25/6/56.

Photo. 91. Experimental plot protected from fire for nearly 20 years, apart from accidental fire in year preceding photo. Showing development of the forest precursor, *Buddleia salviifolia*, and tall grasses and shrubs, and the decay of medium height *Themeda-Trachypogon* Highlands Grassland, all indicating a successional development to Mountain *Podocarpus* Forest in absence of burning and grazing. Above Draycott Hill on Estcourt-Tabamhlope road. 5/1/55.

Photo. 92. Foreground: *Themeda-Tristachya-Digitaria* Northern Highlands Grassland, grazed short by sheep. Background: scrub of forest precursors and forest initials amongst boulders, where protected from fires. The shrubs and trees include *Kiggelaria africana*, *Halleria lucida*, *Clausena anisata*, *Cussonia spicata*, *C.paniculata*, *Scolopia mundii*, *Pittosporum viridiflorum*, *Buddleia salviifolia*, *Canthium ciliatum*, *Diospyros lycioides*, *Myrsine africana*, *Rhus dentata* var. *grandifolia*, *Rhus rehmanniana*, *Cephalanthus natalensis*, *Pavetta cooperi* and the climber, *Rhoicissus tridentata*. Utrecht-Kemp's Lust road. 5,700 ft. 19/11/55.

Photo. 93. Leucosidea sericea encroachment into short, sheep-grazed *Themeda-Tristachya-Digitaria* Northern Highlands Grassland. Fires in short grassland have resulted in coppicing of *L.sericea*, but have not been of sufficient intensity to prevent growth and encroachment. Utrecht-Groenvlei road. c. 6,000 ft. 23/11/55.

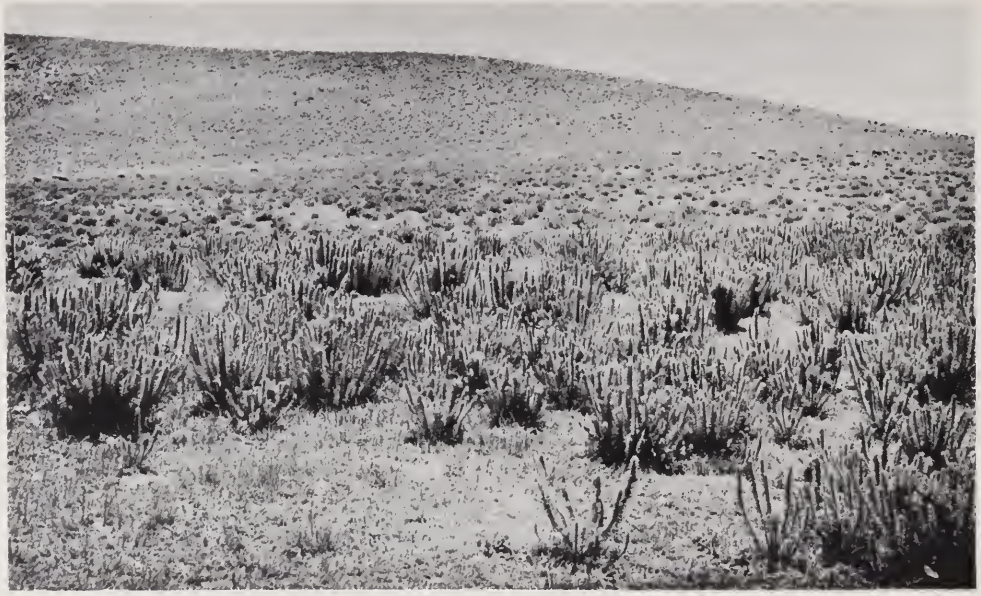


Photo. 94. Secondary encroachment of *Athanasia acerosa* into short, sheep grazed, Secondary *Eragrostis spp.* Grassland, which has replaced *Themeda-Trachypogon* Highlands Grassland as a result of continuous grazing. Low grass cover results in reduced competition and insufficient intensity of fires to prevent encroachment and destroy *A.acerosa.* Ten miles from Qudeni on Nqutu road. 5,100 ft. 6/12/57.

Photo. 95. Encroachment of *Berkheya onopordifolia* into Secondary *Eragrostis spp.* Grassland. Note breakdown of grass cover and entry of weeds. Near Middlerest on Mooi River road. 4,700 ft. 17/3/56.

Table A7. Mean daily minimum and mean lowest monthly temperatures (°C)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Coast Lowlands												
Amatikulu ..	19·7	20·1	19·6	17·3	13·9	11·2	10·8	12·8	14·8	16·3	17·9	19·1
	15·9	16·7	15·7	12·3	8·9	6·9	6·8	7·9	10·3	12·3	13·2	15·2
Stanger ..	19·3	19·9	19·2	16·9	14·8	12·7	12·2	13·3	14·6	16·3	17·7	18·7
	15·4	16·2	15·4	13·1	10·2	8·2	8·3	9·3	10·0	12·1	13·7	14·8
Coast Hinterland												
Eshowe ..	17·7	18·0	17·3	15·6	13·7	11·6	11·0	12·0	13·0	14·5	15·6	17·1
	13·5	14·2	13·5	11·7	8·9	5·4	7·2	7·3	8·0	10·2	11·1	12·5
Valley												
Mfongosi ..	18·5	17·8	17·4	14·4	10·3	6·7	7·3	10·3	12·9	15·7	16·9	18·4
	14·4	14·6	13·2	9·7	5·6	2·8	3·3	5·3	7·2	10·4	11·2	13·4
Nietgedacht ..	15·1	14·7	13·3	9·9	6·0	2·3	2·0	3·8	6·8	11·3	13·0	14·4
	8·9	8·4	8·3	4·1	1·6	−1·3	−1·4	0·1	1·1	5·2	6·1	8·0
Weenen ..	16·2	16·1	14·8	10·8	5·2	0·8	0·8	4·2	7·9	12·2	14·2	15·8
	11·4	10·6	9·7	4·4	−1·3	−4·6	−4·2	−1·6	2·0	6·5	8·4	10·1
Interior Basins												
Vryheid ..	14·7	14·9	14·1	11·2	7·8	5·1	5·2	7·4	9·7	12·0	13·0	14·3
	9·7	10·5	9·1	5·4	1·1	0·6	0·3	0·7	3·6	6·4	7·5	8·7
Ladysmith ..	16·9	16·6	15·2	11·7	6·4	3·1	2·9	6·6	10·3	13·1	14·7	16·1
	13·5	12·3	10·2	5·1	1·2	−2·2	−2·7	−0·7	3·5	8·1	9·5	10·9
Colenso ..	16·4	15·7	14·8	10·8	5·4	2·0	1·9	4·3	8·6	11·8	13·8	15·2
	12·5	11·8	10·4	4·4	0·1	−4·1	−3·1	−0·7	3·1	6·3	8·1	10·2
Estcourt ..	15·0	14·9	13·7	10·4	6·0	2·6	2·4	5·1	8·1	11·3	12·8	14·3
	11·1	11·6	8·9	4·7	1·1	−1·9	−2·5	−0·1	1·8	5·2	7·3	9·1
Dundee ..	14·8	14·7	13·3	10·0	5·8	2·4	2·4	5·2	8·2	11·6	12·8	14·0
	10·3	10·0	8·7	3·9	0·5	−2·7	−2·2	−3·6	1·9	5·6	7·0	9·3
Newcastle ..	15·0	14·9	13·2	9·5	4·7	1·4	1·6	4·9	8·4	11·9	13·1	14·3
	9·9	10·6	8·2	2·7	−1·4	−4·8	−4·9	−1·9	1·1	5·6	7·0	9·1
Midland Mist Belt												
Greytown ..	14·8	15·1	14·3	11·9	9·3	7·1	6·3	8·3	9·9	12·0	12·8	14·4
	10·1	10·2	9·9	6·2	3·4	2·0	1·8	2·1	3·4	5·1	7·3	11·6
Highlands												
Cathkin Park ..	13·3	12·8	12·0	9·1	5·4	3·4	2·6	4·3	6·7	9·1	10·8	12·2
	9·2	9·2	8·4	4·5	0·8	−0·2	−1·4	0·8	1·0	4·6	5·1	8·1
Cathedral Peak	12·2	12·9	11·6	9·7	7·4	5·4	4·6	6·0	8·0	9·3	9·8	11·7
	8·3	7·9	6·7	4·4	1·6	−0·3	−1·6	−0·2	0·5	2·2	5·4	7·3
Volksrust ..	12·8	12·0	10·6	6·4	2·4	−1·0	−1·2	1·5	6·1	9·1	10·8	12·1
	8·1	6·9	5·7	0·0	−3·4	−6·4	−6·4	−5·4	−1·3	3·3	4·5	6·6
Nottingham Road	12·3	12·2	10·5	6·7	1·5	−2·3	−2·5	0·7	4·8	8·1	9·8	11·3
	8·1	7·7	5·1	−0·9	−4·3	−7·1	−7·5	−5·7	−2·1	2·2	4·2	5
Wakkerstroom	11·6	10·9	9·4	5·4	1·2	−2·2	−2·1	0·9	4·4	8·3	9·5	11
	6·3	5·3	3·3	−1·8	−5·9	−8·3	−8·3	−6·5	−4·2	1·7	2·7	5

Mean daily minimum temperatures are given on the top line and the mean lowest monthly temperatures on the bottom line for each station

Table A8. Extreme minimum temperatures and number of months for which no temperatures less than or equal to 2·8°C ever recorded

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mth
Coast Lowlands													
Amatikulu ..	14·3	14·4	12·3	9·7	5·9	4·4	**3·9**	6·0	6·9	10·6	9·4	12·9	12
Stanger ..	12·8	14·4	12·6	10·0	6·1	**5·0**	6·1	6·9	7·8	10·0	10·0	12·2	12
Coast Hinterland													
Eshowe ..	7·8	11·1	6·1	8·2	6·1	3·3	3·3	4·4	**2·3**	7·2	7·8	10·0	11
Valley													
Mfongosi ..	10·8	11·7	10·3	7·2	0·0	0·0	−**0·8**	0·3	3·9	7·2	6·7	10·6	8
Nietgedacht ..	7·8	0·3	2·8	1·1	−1·0	−2·8	−**4·2**	−2·5	−0·6	3·1	1·7	1·9	1
Weenen ..	6·7	6·7	6·1	0·0	−3·9	−5·6	−**6·7**	−5·0	−0·6	0·6	2·2	7·2	4
Interior Basins													
Vryheid ..	1·7	4·4	7·1	2·8	−1·1	−1·7	−4·0	−**5·6**	−0·6	2·8	2·2	4·4	3
Ladysmith ..	11·7	9·4	7·5	1·2	−2·2	−**5·0**	−4·3	−3·2	0·0	3·9	7·2	7·5	6
Colenso ..	7·8	8·3	7·2	0·0	−3·9	−**7·2**	−6·7	−6·1	−0·6	2·8	0·6	3·3	4
Estcourt ..	7·2	7·2	6·6	0·6	−1·7	−5·0	−**6·7**	−5·0	−2·2	1·1	3·3	4·4	5
Dundee ..	6·7	3·9	4·4	0·0	−4·4	−**6·7**	−**6·7**	−5·0	−3·9	0·6	1·7	6·7	4
Newcastle ..	4·9	6·1	4·2	−1·1	−6·1	−8·3	−**10·0**	−6·7	−4·9	0·0	−0·6	3·9	4
Midland Mist Belt													
Greytown ..	5·9	7·8	6·9	3·8	0·4	0·0	−0·6	−**2·1**	0·0	3·1	3·3	6·6	7
Highlands													
Cathkin Park ..	7·2	7·2	4·4	1·1	−2·2	−6·7	−**7·8**	−1·7	−1·7	2·8	1·1	6·1	4
Cathedral Peak	5·1	5·6	4·7	2·2	−0·8	−**3·6**	−3·1	−3·1	−0·3	−2·0	3·4	6·3	5
Nottingham Road	5·6	5·0	2·2	−3·3	−6·7	−9·4	−9·4	−**10·0**	−6·7	−2·8	0·0	1·1	2
Volksrust ..	5·6	4·7	2·8	−3·9	−10·0	−9·9	−**10·6**	−8·4	−4·1	0·0	2·9	4·2	4
Wakkerstroom	1·2	2·0	−0·7	−5·3	−10·4	−11·8	−12·7	−**13·3**	−10·5	−2·2	−2·3	1·8	0

Table A9. Mean daily ranges of temperature (°C)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Coast Lowlands													
Amatikulu	10·5	10·6	10·2	10·3	12·1	12·9	12·9	12·2	11·3	10·9	10·5	10·6	11·2
Stanger	8·9	9·4	9·3	10·5	10·5	11·3	11·2	11·5	10·9	10·3	9·3	9·6	10·3
Coast Hinterland													
Eshowe	9·1	9·1	8·9	9·5	9·6	10·0	10·2	10·5	10·4	9·9	9·7	9·0	9·7
Valley													
Mifongosi	11·9	11·8	11·7	13·4	13·7	14·2	13·9	14·2	14·1	12·5	12·3	11·8	12·9
Netgedacht	15·8	15·1	15·4	17·0	18·2	19·0	18·6	20·0	19·0	16·7	15·8	15·6	17·2
Weenen	15·0	14·1	14·2	16·2	19·0	20·5	20·2	19·7	18·4	15·9	14·7	14·6	16·9
Interior Basins													
Vryheid	12·6	12·2	11·7	13·5	14·1	15·0	14·7	15·0	14·4	13·3	13·0	12·7	13·5
Ladysmith	12·7	12·6	12·3	14·2	16·6	17·6	18·0	17·2	16·2	14·2	14·1	13·6	15·0
Colenso	14·0	13·9	12·9	15·5	17·5	17·9	18·3	19·3	17·5	15·9	14·6	14·7	16·0
Estcourt	12·3	12·0	11·9	13·6	15·2	16·3	16·3	16·3	16·0	14·1	13·3	12·8	14·2
Dundee	12·7	12·3	12·3	14·4	16·2	17·1	17·2	17·2	16·4	14·5	13·8	13·7	14·8
Newcastle	13·4	12·8	13·2	15·6	17·8	18·7	18·5	18·2	17·3	15·2	14·6	14·6	15·8
Midland Mist Belt													
Greytown	11·2	10·7	10·0	11·4	11·9	11·6	12·3	12·9	12·5	11·7	11·8	11·2	11·6
Highlands													
Cathkin Park ..	13·8	13·8	13·3	14·8	16·3	15·8	16·6	17·1	16·7	16·0	14·8	14·2	15·2
Cathedral Peak ..	8·6	7·8	8·3	9·2	9·0	9·2	9·7	10·4	11·2	11·0	10·4	9·4	9·6
Nottingham Road ..	11·4	11·5	12·2	14·6	17·9	19·5	19·6	19·1	16·9	14·3	13·0	12·4	15·2
Volksrust	11·5	11·7	12·2	14·7	16·2	17·3	17·0	17·4	15·6	13·8	12·1	11·9	14·3
Wakkerstroom ..	12·9	13·1	13·8	16·1	17·8	18·6	18·5	18·2	17·0	14·8	13·5	13·3	15·8

Table A10. Annual ranges of temperature (C)

	Mean Daily Temperatures	Mean Monthly Extremes
Coast Lowlands		
Amatikulu ..	19·9	32·8
Stanger	17·1	29·2
Coast Hinterland		
Eshowe	16·1	29·8
Valley		
Mfongosi ..	23·7	37·9
Nietgedacht ..	28·9	39·0
Weenen	30·4	43·5
Interior Basins		
Vryheid	22·2	34·2
Ladysmith ..	26·8	39·6
Colenso	28·5	40·7
Estcourt	24·9	37·0
Dundee	25·3	38·2
Newcastle ..	27·5	40·6
Midland Mist Belt		
Greytown ..	19·7	32·1
Highlands		
Cathkin Park ..	24·5	34·6
Cathedral Peak ..	16·2	30·3
Nottingham Road	26·2	39·2
Volksrust ..	25·5	37·0
Wakkerstroom ..	26·7	38·3

*Annual range of temperature is the difference between the highest and lowest mean daily maxima and minima, or the difference between the highest and lowest mean monthly temperature extremes

Table A11. Months with mean temperatures above specified limits

	⩾25°C	⩾20°C	⩾15°C	⩾10°C
Coast Lowlands				
Amatikulu	February (1)	September to April (8)	Year (12)	Year (12)
Stanger	—	September to May (9)	Year (12)	Year (12)
Coast Hinterland				
Eshowe	—	November to April (6)	Year (12)	Year (12)
Valley				
Mfongosi	—	October to April (7)	August to May (10)	Year (12)
Nietgedacht ..	—	November to March (5)	September to May (9)	Year (12)
Weenen	—	October to March (6)	September to April (8)	Year (12)
Interior Basins				
Vryheid	—	December to February (3)	September to April (8)	Year (12)
Ladysmith	—	October to March (6)	August to April (9)	Year (12)
Colenso	—	November to March (5)	September to April (8)	Year (12)
Estcourt	—	December to February (3)	September to April (8)	Year (12)
Dundee	—	December to February (3)	September to April (8)	Year (12)
Newcastle	—	November to February (4)	September to April (8)	Year (12)
Midland Mist Belt				
Greytown	—	December to February (3)	September to May (9)	Year (12)
Highlands				
Cathkin Park ..	—	January (1)	September to April (8)	Year (12)
Cathedral Peak ..	—	—	November to March (5)	August to March (8)
Nottingham Road..	—	—	October to March (6)	August to May (10)
Volksrust	—	—	October to March (6)	August to May (10)
Wakkerstroom ..	—	—	October to March (6)	August to May (10)

Table A12. Mean monthly and annual temperatures (°C)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Coast Lowlands													
Amatikulu	24·9	25·4	24·7	22·4	19·9	17·7	17·3	18·9	20·4	21·8	23·2	24·4	21·8
Stanger	23·7	24·6	23·8	22·2	20·1	18·4	17·8	18·8	20·1	21·4	22·3	23·5	21·4
Coast Hinterland													
Eshowe	22·2	22·6	21·8	20·3	18·5	16·6	16·1	17·3	18·2	19·5	20·4	21·6	19·6
Valley													
Mfongosi	24·4	23·6	23·3	21·1	17·2	13·8	14·3	17·4	19·9	21·9	23·1	24·3	20·4
Nietgedacht	23·0	22·3	21·0	18·4	15·1	11·8	11·3	13·8	16·3	19·6	20·9	22·2	18·0
Weenen	23·7	23·1	21·9	18·9	14·7	11·1	10·9	14·1	17·2	20·2	21·6	23·1	18·4
Interior Basins													
Vryheid	20·9	21·1	19·9	17·9	14·8	12·6	12·6	14·9	16·8	18·7	19·5	20·6	17·6
Ladysmith	23·3	22·9	21·3	18·8	14·7	11·9	11·9	15·2	18·3	20·2	21·7	22·9	18·6
Colenso	23·4	22·6	21·3	18·6	14·2	10·9	11·1	13·9	17·3	19·7	21·1	22·6	18·1
Estcourt	21·1	20·9	19·7	17·2	13·6	10·7	10·5	13·3	16·1	18·3	19·5	20·7	16·8
Dundee	21·1	20·9	19·5	17·2	13·9	11·0	11·0	13·8	16·4	18·8	19·7	20·8	17·0
Newcastle	21·7	21·3	19·8	17·3	13·6	10·7	10·9	14·0	17·1	19·5	20·4	21·6	17·3
Midland Mist Belt													
Greytown	20·4	20·4	19·3	17·6	15·3	12·9	12·4	14·7	16·2	17·8	18·7	20·1	17·2
Highlands													
Cathkin Park ..	20·2	19·7	18·6	16·5	13·6	11·3	10·9	12·8	15·1	17·1	18·2	19·3	16·1
Cathedral Peak ..	16·5	16·8	15·7	14·3	11·9	10·0	9·4	11·2	13·6	14·8	15·0	16·4	13·8
Nottingham Road ..	18·0	17·9	16·6	14·0	10·5	7·5	7·3	10·3	13·3	15·3	16·3	17·5	13·7
Volksrust	18·5	17·8	16·7	13·7	10·5	7·6	7·3	10·2	13·9	16·0	16·8	18·1	13·9
Wakkerstroom ..	18·1	17·5	16·3	13·5	10·1	7·1	7·1	10·0	12·9	15·7	16·3	17·7	13·5

Table A13. Mean monthly and annual rainfall (mm)

	Alt. (ft.)	No. of Years	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Coast Lowlands															
1,001–1,250 mm															
Gingindhlovu ..	(150)	29	1,100	122	130	128	77	76	58	38	43	68	98	123	139
Stanger	(150)	27	1,056	131	114	138	74	51	31	35	41	61	115	115	122
Coast Hinterland															
801–1,000 mm															
Krantzkop ..	(3,770)	23	872	122	112	96	56	39	18	15	25	37	82	122	143
Nkandla ..	(3,590)	30	889	122	133	103	59	35	22	16	20	42	87	116	134
Elandsvlei ..	(3,500)	27	909	122	123	112	53	36	23	20	30	45	79	111	142
Frogmore ..	(3,200)	23	961	128	125	110	61	41	24	20	30	47	83	135	156
1,001–1,250 mm															
Eshowe	(1,740)	30	1,270	170	161	155	80	66	41	32	44	76	129	155	176
Mapumulo ..	(1,800)	29	1,104	153	149	142	64	48	29	22	37	59	106	141	153
Valley															
601–700 mm															
Impahlasini ..	(3,780)	27	618	92	85	66	32	25	12	12	20	26	57	87	102
Inadi	(2,630)	28	631	101	95	71	33	23	10	11	16	24	62	84	102
Weenen ..	(2,780)	27	637	107	93	78	38	16	10	10	18	23	52	85	107
Tugela Ferry ..	(1,800)	30	638	102	87	79	37	20	11	10	16	28	56	82	107
Lootshoek ..	(2,780)	27	675	95	86	83	40	23	9	11	19	28	63	105	115
Wintershoek ..	(4,300)	24	698	109	103	79	41	29	16	13	19	30	63	90	110
701–800 mm															
Mfongosi ..	(1,400)	27	759	119	104	92	43	30	16	16	19	30	71	93	127
Interior Basins															
601–700 mm															
Fitty Park ..	(3,400)	27	643	106	89	71	28	23	12	12	17	23	57	96	106
Vredefontein ..	(4,000)	22	681	111	121	80	37	17	9	13	16	26	51	94	113
Swaarverdient ..	(4,000)	25	683	117	129	76	35	23	9	17	12	20	56	85	106
Waaihoek ..	(4,190)	27	685	117	109	82	32	18	10	16	16	26	60	90	105
Rongpoort ..	(4,730)	26	697	107	99	92	41	22	11	13	19	34	60	91	112
Middleton ..	(4,250)	27	697	99	91	87	38	27	14	14	18	31	69	95	113
Interior Basins															
701–800 mm															
Draycott ..	(3,700)	24	713	127	114	92	41	13	8	10	15	25	57	90	110
Bluebank ..	(3,600)	30	713	131	124	85	44	19	12	14	16	31	52	82	100
Estcourt Gaol ..	(3,880)	30	717	117	105	92	43	20	9	12	16	21	57	93	118
Bergville ..	(3,700)	26	744	127	125	103	45	24	10	14	16	25	60	90	105
Glennifer ..	(4,000)	30	744	130	110	89	45	23	10	13	19	34	63	92	112
Mount Royal ..	(4,350)	30	757	129	128	89	43	23	11	13	16	33	63	98	111
Utrecht	(3,930)	30	772	128	121	87	36	24	17	16	14	32	72	103	113
Colenso ..	(3,150)	30	776	126	127	91	47	22	10	13	19	33	67	99	119
Ladysmith Convent	(3,480)	30	778	135	129	92	39	20	11	14	19	33	67	99	120
Isandhlwana ..	(4,060)	23	761	122	107	77	38	26	12	13	20	30	75	114	131
Sutherland ..	(3,750)	30	780	134	115	83	45	23	13	13	16	33	69	107	127
Swartwater ..	(4,500)	24	783	131	114	83	40	27	12	13	15	29	73	107	127
Nqutu	(4,350)	30	788	122	116	94	36	23	14	13	17	34	70	104	126
Residence ..	(4,250)	30	789	128	111	85	47	24	14	13	17	34	71	104	131
Bonheim ..	(3,640)	24	796	149	118	118	43	20	11	10	17	28	67	104	131
Try Again ..	(4,600)	30	800	154	122	84	46	22	14	13	17	30	67	106	130
Struisvogelpoort	(4,800)	22	800	152	116	104	36	21	15	13	9	33	68	106	128

Table A13. Mean monthly and annual rainfall (mm) — continued

	Alt. (ft.)	No. of Years	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	De
Interior Basins															
801–1,000 mm															
Waldheim ..	(3,580)	24	804	142	107	89	45	23	14	16	18	28	69	111	14
Ballengeich ..	(4,100)	30	816	150	128	99	41	22	12	15	14	33	68	113	12
Dundee ..	(4,120)	30	817	134	118	103	44	24	13	15	16	35	72	112	13
Loskop.. ..	(4,300)	29	829	149	141	101	43	23	14	16	13	33	69	95	13
Glencoe ..	(4,300)	21	844	151	125	97	54	26	11	14	18	31	69	116	13
Moorside ..	(4,000)	29	846	155	133	112	52	17	10	15	16	37	71	110	12
Vryheid Gaol ..	(3,920)	29	847	136	121	102	50	22	17	14	14	36	82	113	13
Spring Grove ..	(3,700)	28	878	162	133	105	49	23	11	14	16	38	68	110	14
Newcastle Convent	(3,940)	30	879	162	151	108	43	26	12	18	13	32	67	113	12
Martinusdrift ..	(3,700)	22	888	143	136	121	49	24	16	15	10	35	77	127	12
Balbrogie ..	(3,300)	30	889	155	138	109	50	24	13	16	19	39	75	116	13
Bryn Eva ..	(4,000)	26	916	140	152	131	54	36	14	20	19	35	66	106	14
Mon Repos ..	(4,300)	24	930	173	148	114	56	29	15	15	19	32	72	120	15
Hampton ..	(4,400)	23	937	182	153	113	45	23	17	16	16	39	70	114	14
Geluksberg ..	(3,950)	15	1,000	184	167	131	62	29	17	18	30	31	82	115	13
Midland Mist Belt															
801–1,000 mm															
Kromberg Estate ..(4,400)		26	960	140	136	110	58	38	24	17	31	53	90	119	14
Greytown .. ..(3,640)		26	961	139	126	135	51	26	14	19	23	56	94	130	14
1,251–1,500 mm															
Woodlands .. ..(4,770)		25	1,425	228	200	157	82	43	34	24	38	72	136	188	22
Highlands															
701–800 mm															
Wakkerstroom	(5,800)	30	757	119	108	84	40	20	11	14	12	32	75	115	12
Helpmekaar ..	(4,900)	30	773	132	114	86	32	24	14	13	16	34	70	110	12
Glendoone ..	(5,300)	24	793	126	112	104	47	22	14	17	18	38	67	107	12
801–1,000 mm															
Volksrust ..	(5,470)	24	806	118	130	95	34	25	12	14	10	25	78	117	13
Hoffenthal ..	(5,000)	24	833	118	151	116	53	25	12	14	17	27	67	108	12
Klipfontein ..	(5,000)	24	833	132	118	118	42	27	14	14	17	28	74	110	14
Middelin ..	(4,900)	26	857	161	133	106	39	28	12	14	14	39	61	115	13
Nottingham Road	(4,720)	30	858	126	131	104	51	25	12	15	36	40	68	104	14
Torwood ..	(5,100)	22	928	139	152	117	66	30	14	18	25	39	72	116	14
East Meshlyn ..	(5,500)	29	978	180	155	136	52	29	15	19	21	40	69	108	15
Highlands															
1,001–1,250 mm															
Van Reenen's Pass	(5,440)	26	1,013	183	158	124	57	26	13	20	22	45	83	132	15
Clifford Chambers	(4,500)	27	1,013	170	195	133	49	22	18	20	23	35	84	123	14
Munro's Winkel	—	20	1,079	189	185	132	67	27	13	15	18	39	106	132	15
Wyford.. ..	(5,000)	30	1,082	198	181	139	60	26	15	17	21	46	90	134	15
1,251–1,500 mm															
Grosvenor D[illegible]	(5,000)	21	1,251	215	208	154	68	29	17	26	27	60	112	152	18
Moedersru[illegible]	(6,200)	23	1,332	253	213	175	82	34	20	16	25	42	120	150	19

Photo. 96. Scrub encroachment by *Aster filifolius* into poor, secondary grass cover in transition from *Themeda-Hyparrhenia* Grassland to *Themeda-Trachypogon* Highlands Grassland. Note severe soil erosion and inadequacy of *A.filifolius* shrubs to prevent this. Draycott Location, Estcourt district. c. 4,500 ft. 12/12/61.

Photo. 97. Secondary scrub encroachment by the introduced 'Gorse' (*Ulex europaeus*) at upper altitudes of Highlands Region. Highmoor Forestry Station. ca. 6,700 ft. 11/12/61.

Photo. 98. Streambank *Leucosidea sericea* Scrub and clear mountain waters of upper Bushmans River. *Arundinella nepalense* in lower, left hand corner. Giant's Castle Game Reserve. ca. 5,400 ft. 29/7/57.

Photo. 99. Scattered tree ferns, *Cyathea dregei*, along small stream in *Protea* Savanna. Royal Natal National Park. 6,200 ft. 25/1/55.

Photo. 100. Community of flowering *Protea dracomontana*, with trees of *P.rouppelliae* in background. On shallow soils overlying Cave Sandstone. Royal Natal National Park. ca. 6,000 ft. 24/1/55.

Photo. 101. Foreground: *Protea multibracteata* Savanna on relatively deep, well drained soils. Middle distance: *P.rouppelliae* Savanna along rocky, low ridges, with shallow soils and sparse grass cover, flanked by narrow, interrupted line of *P.multibracteata* on deeper soils. Distance: Interior Basins Region with *Themeda-Hyparrhenia* Grassland. View east from Surprise Ridge area, Royal Natal National Park. 5/5/55.

Photo. 102. View of *Erythrina latissima* community on north-west, rocky, dolerite hillside in transition from Highlands Region to Interior Basins Region. Note *Acacia karroo* clump at right. Scattered amongst the boulders and in the bush clumps are forest precursors and forest initials: *Rapanea melanophloeos*, *Cephalanthus natalensis*, *Pachystigma macrocalyx*, *Greyia sutherlandii*, *Rhus dentata* var. *grandifolia*, *Carissa bispinosa*, *Diospyros whyteana*, *Cymbopogon validus*, *Cyathea dregei*, *Ekebergia pterophylla* and other species. Twenty miles from Nqutu on Qudeni road. 4,600 ft. 21/11/57.

Photo. 103. Dense *Hypericum revolutum* forest precursor scrub. Chief forest initials present are *Halleria lucida*, *Podocarpus latifolius*, *Trimeria grandifolia*, *Rhus legatii*, *Dais cotinifolia*, *Kiggelaria africana*. Ntshiza, Qudeni. 5,500 ft. 5/7/57.

Table A14. Months with frequency of 75% or more of rainfall over specified limits

	⩾10 mm	⩾25 mm	⩾50 mm	⩾75 mm	⩾100 mm
Coast Lowlands					
1,001–1,250 mm					
Gingindhlovu ..	Year	Sep.–Apr. (8)	Oct.–Mar. (6)	Dec., Jan., Mar. (3)	Dec. (1)
Stanger	Aug.–May (10)	Sep.–Apr. (8)	Oct.–Mar. (6)	Mar. (1)	—
Coast Hinterland					
801–1,000 mm					
Krantzkop ..	Sep.–Apr. (8)	Oct.–Mar. (6)	Oct.–Mar. (6)	Nov.–Mar. (5)	—
Nkandla	Sep.–Apr. (8)	Oct.–Mar. (6)	Oct.–Mar. (6)	Jan., Feb. (2)	—
Elandsvlei	Sep.–Apr. (8)	Oct.–Apr. (7)	Oct.–Mar. (6)	Dec.–Mar. (4)	—
Frogmore	Sep.–Apr. (8)	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Feb. (4)	—
1,001–1,250 mm					
Mapumulo ..	Sep.–May (8)	Sep.–Apr. (8)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec.–Feb. (3)
Eshowe	Aug.–June (11)	Sep.–Apr. (8)	Oct.–Mar. (6)	Oct.–Mar. (6)	Oct.–Jan., Mar. (5)
Valley					
601–700 mm					
Impahlasini ..	Oct.–Apr. (7)	Oct.–Mar. (6)	Dec.–Jan. (2)	—	—
Inadi	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Feb. (4)	—	—
Weenen	Oct.–Apr. (7)	Oct.–Mar. (6)	Dec.–Jan., Mar. (3)	—	—
Tugela Ferry ..	Oct.–Mar. (6)	Oct.–Mar. (6)	Nov.–Feb. (4)	—	—
Lootshoek ..	Sep.–Apr. (8)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec. (1)	—
Wintershoek ..	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Jan. (1)	—
701–800 mm					
Mfongosi	Sep.–Apr. (8)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec. (1)	—
Interior Basins					
601–700 mm					
Fitty Park	Oct.–Mar. (6)	Oct.–Mar. (6)	Dec.–Mar. (4)	—	—
Vredefontein ..	Sep.–Apr. (8)	Oct.–Mar. (6)	Dec.–Feb. (3)	Feb. (1)	—
Swaarverdient ..	Oct.–Apr. (7)	Oct.–Mar. (6)	Dec.–Feb. (3)	Feb. (1)	—
Waaihoek	Oct.–Apr. (7)	Oct.–Mar. (6)	Dec.–Mar. (4)	—	—
Rongpoort ..	Oct.–Apr. (7)	Oct.–Mar. (6)	Dec.–Mar. (4)	Dec. (1)	—
Middleton ..	Oct.–Apr. (7)	Oct.–Mar. (6)	Oct.–Mar. (6)	Dec. (1)	—
701–800 mm					
Draycott	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec.–Jan. (2)	—
Bluebank	Oct.–Apr. (7)	Oct.–Mar. (6)	Dec.–Mar. (4)	—	—
Estcourt	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec., Feb. (2)	—
Bergville	Oct.–Apr. (7)	Oct.–Mar. (6)	Dec.–Mar. (4)	Jan. (1)	—
Glennifer	Oct.–Apr. (7)	Oct.–Apr. (7)	Dec.–Mar. (4)	Dec.–Feb. (3)	—
Mt. Royal ..	Sep.–Apr. (8)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec. Feb. (3)	—
Utrecht	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Feb. (1)	—
Colenso	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Jan. Feb. (2)	—
Ladysmith ..	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec. Feb. (3)	—
Isandhlwana ..	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec.–Jan (2)	—
Sutherland ..	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Nov. Jan. (3)	—
Swartwater ..	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec. Feb. (3)	—
Nqutu	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec. (1)	—

Table A14. Months with frequency of 75% or more of rainfall over specified limits—continued

	⩾10 mm	⩾25 mm	⩾50 mm	⩾75 mm	⩾100 mm
Interior Basins—continued					
701–800 mm					
Residence	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec. (1)	—
Bonheim	Oct.–Apr. (7)	Oct.–Mar. (6)	Dec.–Mar. (4)	Dec.–Mar. (4)	—
Try Again	Oct.–Mar. (6)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec.–Jan. (2)	Jan. (1)
Struisvogelpoort ..	Oct.–Apr. (7)	Oct.–Mar. (6)	Dec.–Mar. (4)	Dec.–Feb. (3)	Jan. (1)
801–1,000 mm					
Waldheim	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec. (1)	Dec. (1)
Ballengeich ..	Oct.–Apr. (7)	Oct.–Mar. (6)	Dec.–Mar. (4)	Dec.–Feb. (3)	—
Dundee	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec.–Feb. (3)	—
Loskop	Sep.–Apr. (8)	Oct.–Mar. (6)	Dec.–Mar. (4)	Dec.–Jan. (2)	Jan. (1)
Glencoe	Sep.–Apr. (8)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec., Jan., Mar. (3)	—
Moorside	Oct.–Apr. (7)	Oct.–Mar. (6)	Oct.–Mar. (6)	Dec., Feb. (3)	—
Vryheid	Sep.–Apr. (8)	Oct.–Apr. (7)	Nov.–Mar. (5)	Dec.–Feb. (3)	—
Spring Grove ..	Sep.–Apr. (8)	Oct.–Mar. (6)	Nov.–Mar. (5)	Jan.–Feb. (2)	—
Newcastle	Sep.–Apr. (8)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec.–Feb. (3)	Jan. (1)
Martinusdrift ..	Sep.–Apr. (8)	Oct.–Mar. (6)	Nov.–Mar. (5)	Jan.–Feb. (2)	—
Balbrogie	Sep.–Apr. (8)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec.–Mar. (4)	Jan. (1)
Bryn Eva	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec.–Mar. (4)	—
Mon Repos ..	Sep.–Apr. (8)	Oct.–Apr. (7)	Nov.–Mar. (5)	Dec.–Mar. (4)	Jan. (1)
Hampton	Sep.–Apr. (8)	Oct.–Mar. (6)	Dec.–Mar. (4)	Dec.–Feb. (3)	Jan. (1)
Geluksberg ..	Sep.–Apr. (8)	Oct.–Apr. (7)	Dec.–Mar. (4)	Dec.–Feb. (3)	Feb. (1)
Midland Mist Belt					
801–1,000 mm					
Kromberg	Sep.–Apr. (8)	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec.–Jan. (2)
Greytown	Sep.–Apr. (8)	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Jan. (1)
1,251–1,500 mm					
Woodlands ..	Aug.–Apr., Jun. (10)	Sep.–Apr. (8)	Oct.–Apr. (7)	Oct.–Mar. (6)	Oct.–Mar. (6)
Highlands					
701–800 mm					
Wakkerstroom ..	Sep.–Apr. (8)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec.–Feb. (3)	—
Helpmekaar ..	Oct.–Mar. (6)	Oct.–Mar. (6)	Dec.–Mar. (4)	Jan. (1)	—
Glendoone ..	Sep.–Apr. (8)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec.–Mar. (4)	—
801–1,000 mm					
Volksrust	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec.–Jan. (2)	—
Hoffenthal ..	Sep.–Apr. (8)	Oct.–Mar. (6)	Dec.–Mar. (4)	Dec.–Feb. (3)	Feb. (1)
Klipfontein ..	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec.–Mar. (4)	—
Middelin	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec.–Feb. (3)	Jan. (1)
Nottingham Road	Sep.–Apr. (8)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec.–Mar. (4)	Dec. (1)
Torwood	Sep.–Apr. (8)	Oct.–Apr. (7)	Nov.–Mar. (5)	Nov.–Mar. (5)	Dec.–Jan. (2)
East Meshlyn ..	Sep.–Apr. (8)	Oct.–Mar. (6)	Oct.–Mar. (6)	Dec.–Mar. (4)	Jan.–Feb. (2)
1,001–1,250 mm					
Van Reenen's Pass	Sep.–Apr. (8)	Oct.–Mar. (6)	Oct.–Mar. (6)	Dec.–Mar. (4)	Jan. (1)
Clifford Chambers	Oct.–Apr. (7)	Oct.–Mar. (6)	Dec.–Mar. (4)	Dec.–Feb. (3)	Feb. (1)
Munro's Winkel ..	Sep.–Apr. (8)	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec.–Feb. (3)
Wyford	Sep.–Apr. (8)	Oct.–Apr. (7)	Oct.–Mar. (6)	Dec.–Mar. (4)	Dec.–Feb. (3)
1,251–1,500 mm					
Grosvenor Downs	Sep.–Apr. (8)	Oct.–Apr. (7)	Oct.–Mar. (6)	Nov.–Mar. (5)	Dec.–Mar. (4)
Moedersrust ..	Sep.–Apr. (8)	Oct.–Apr. (7)	Oct.–Mar. (6)	Oct.–Mar. (6)	Dec.–Mar. (4)

TEMPERATURE AND ALTITUDE, SHOWING GREATER EXTREMES OF TEMPERATURE OBTAINED IN THE TUGELA VALLEY, AND LOCALLY IN OTHER REGIONS, DUE MAINLY TO INFLUENCE OF TOPOGRAPHY

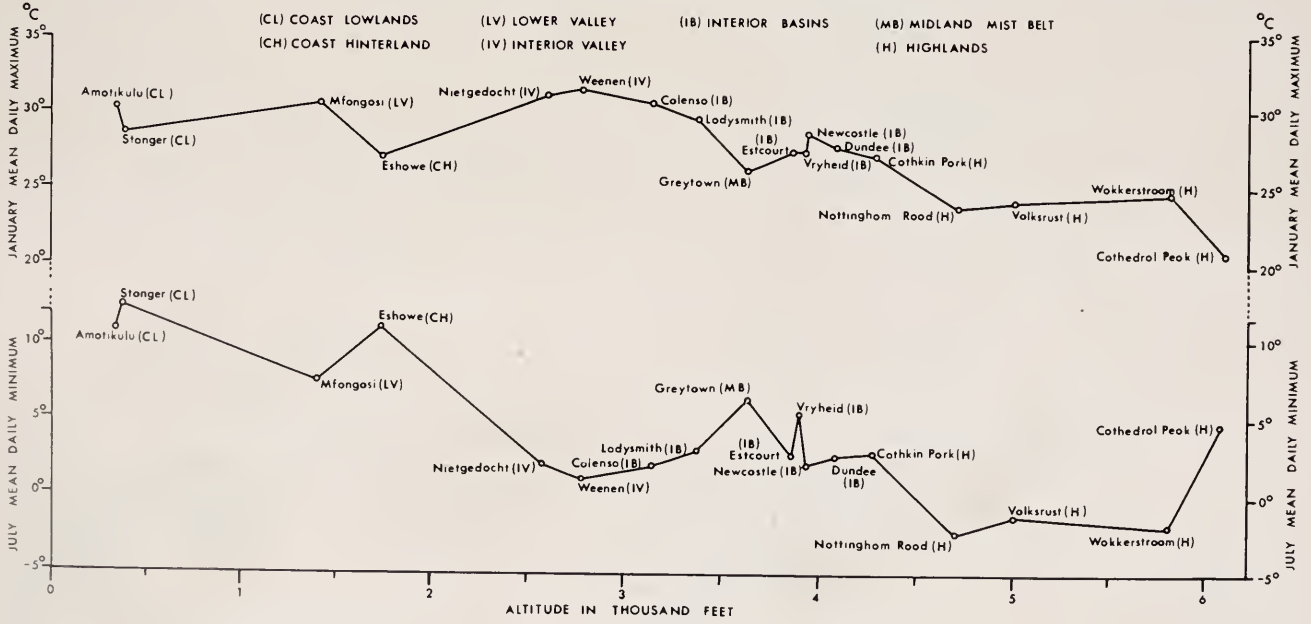


FIG. A1

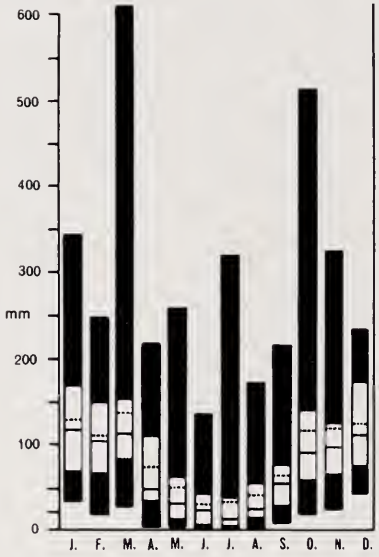
MONTHLY AND ANNUAL MEANS, MEDIANS, AND QUARTERLIES OF RAINFALL

COAST LOWLANDS
1001-1250 mm

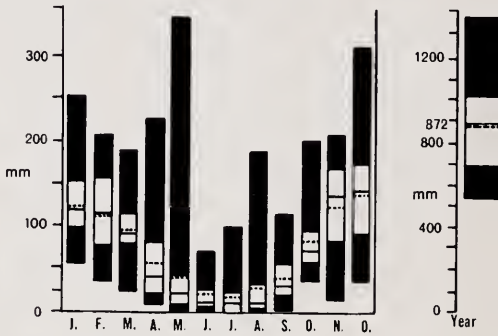
FIG. A2

COAST HINTERLAND
801-1000 mm

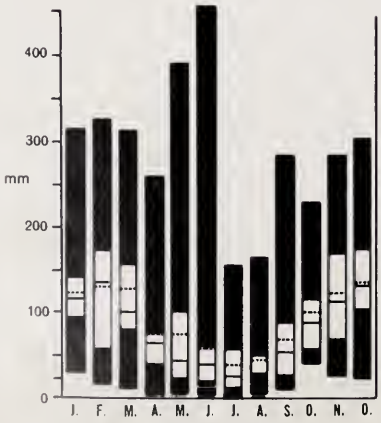
Stanger



Kranskop



Gingindlovu



Nkandla

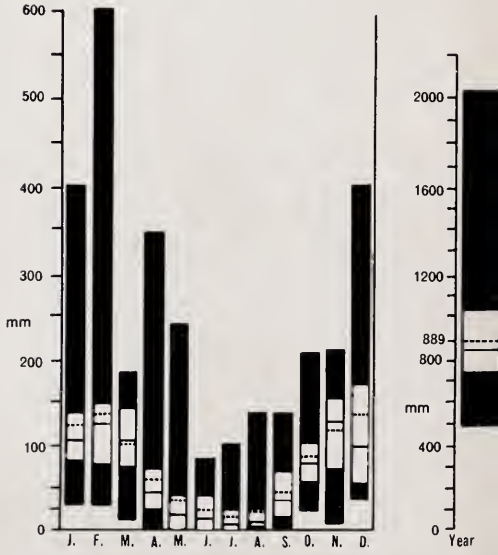
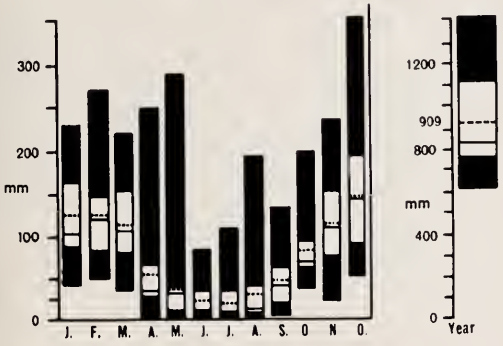


FIG. A 2 (Cont.)

COAST HINTERLAND

801-1000 mm

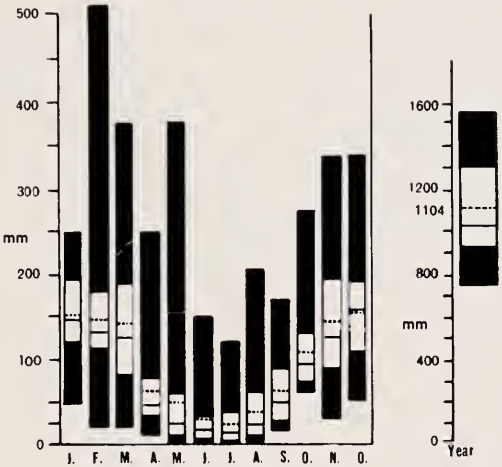
Elandsvlei



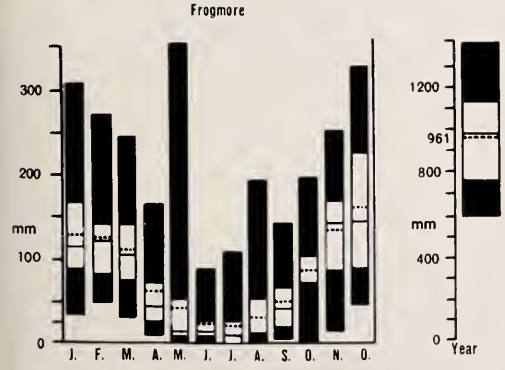
COAST HINTERLAND

1001-1250 mm

Mapumulo



Frogmore



Eshowe

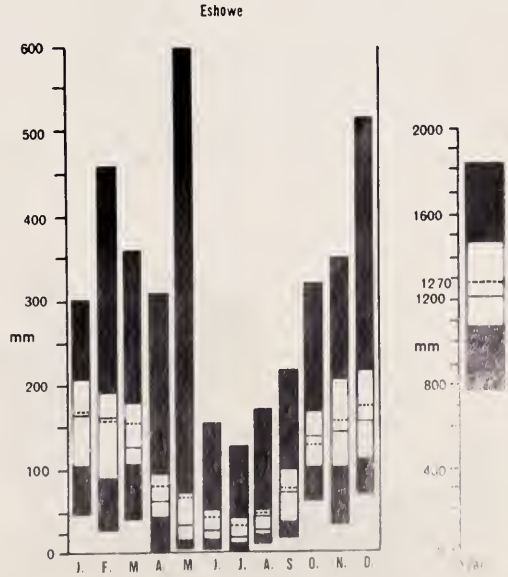
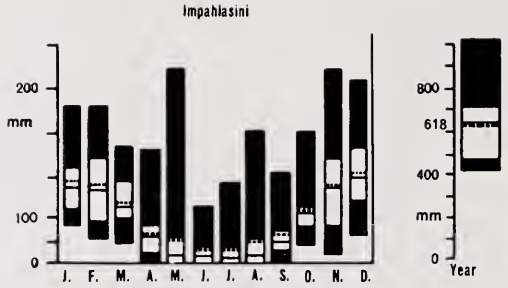
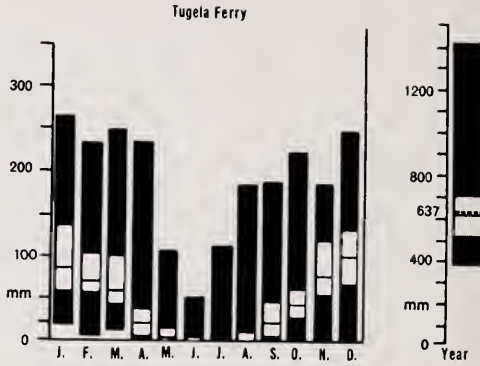


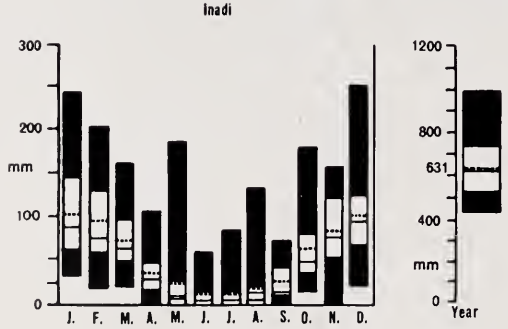
FIG. A2 (Cont.)

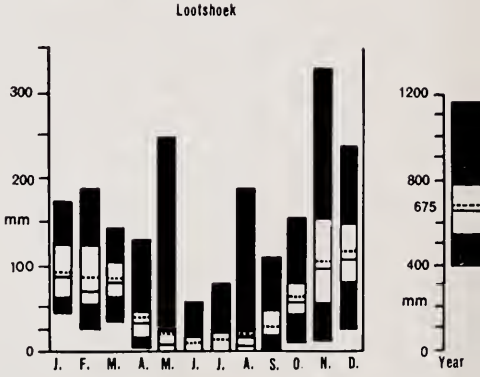
VALLEY

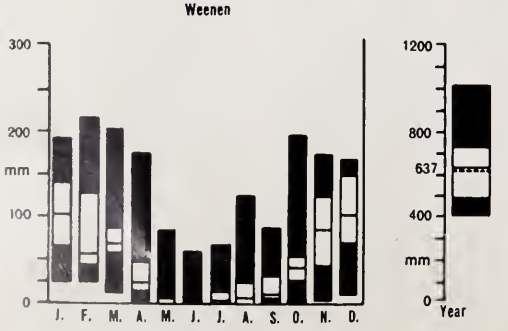
601-700 mm











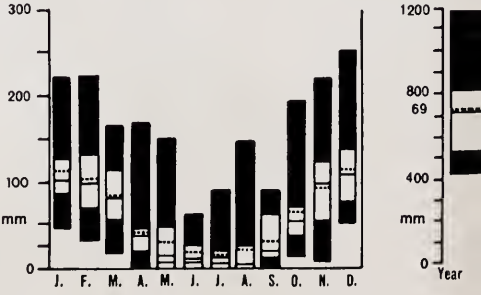


FIG. A2 (Cont.)

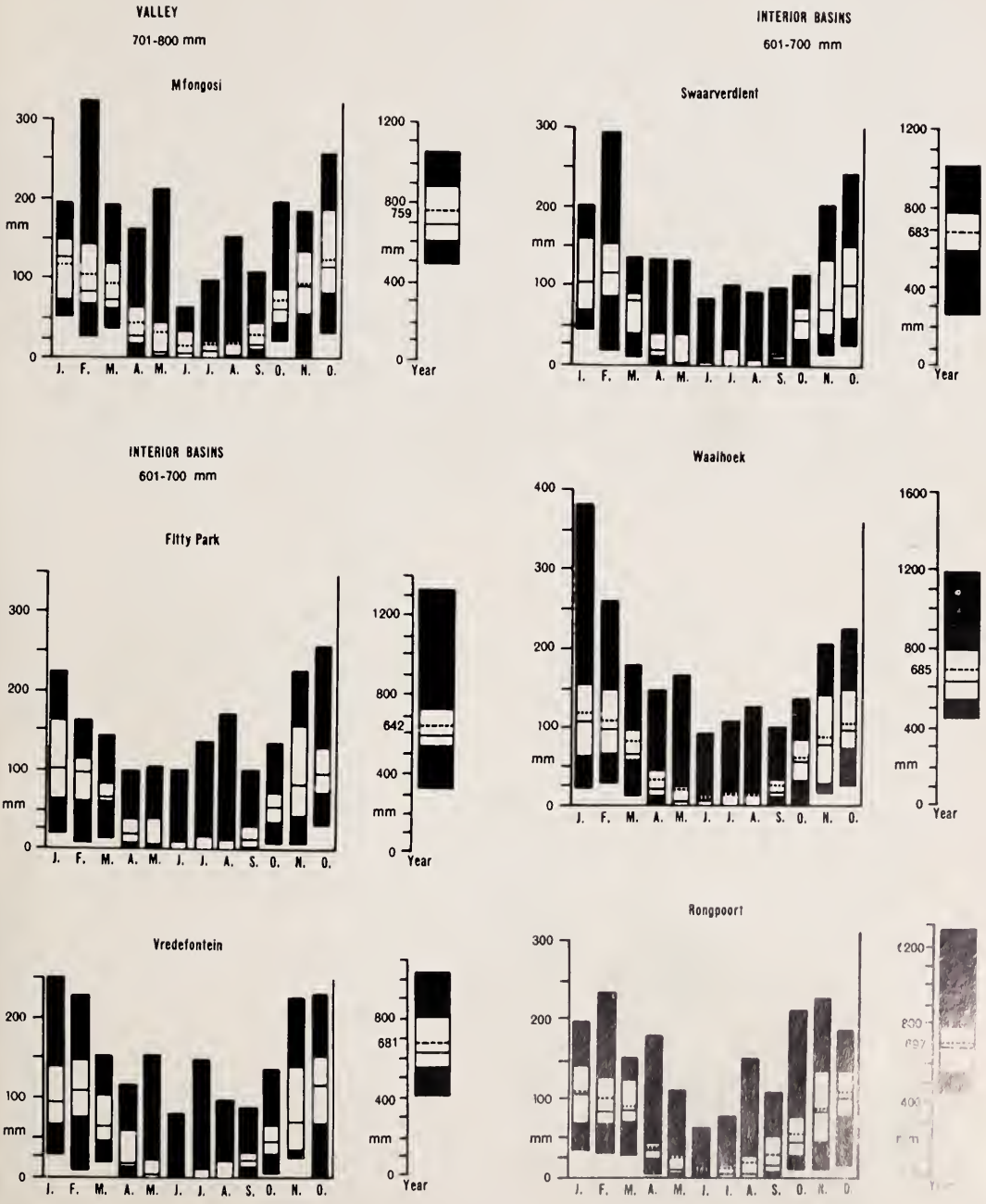
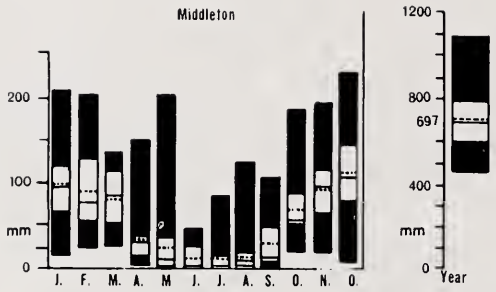

VALLEY
701-800 mm
Mfongosi
INTERIOR BASINS
601-700 mm
Swaarverdient
INTERIOR BASINS
601-700 mm
Fitty Park
Waalhoek
Vredefontein
Rongpoort
mm
Year
J. F. M. A. M. J. J. A. S. O. N. O.

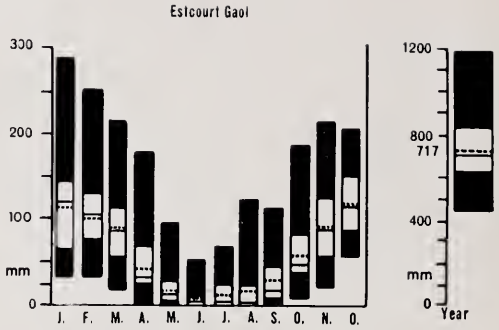
FIG. A2 (Cont.)

INTERIOR BASINS

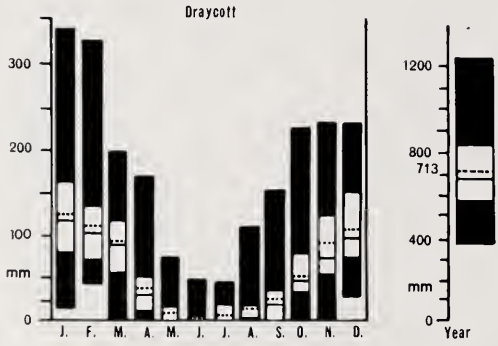
601-700 mm

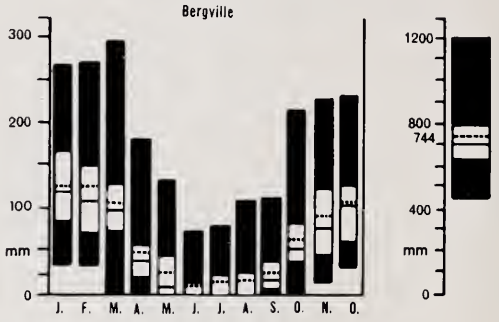


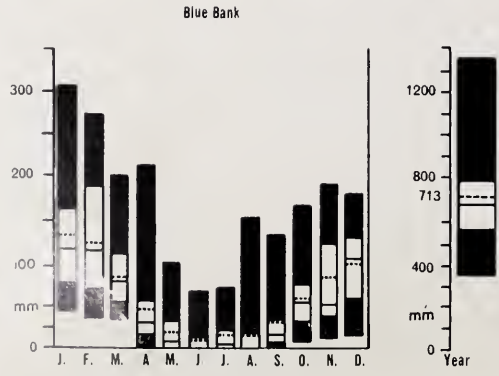
701-800 mm



701-800 mm







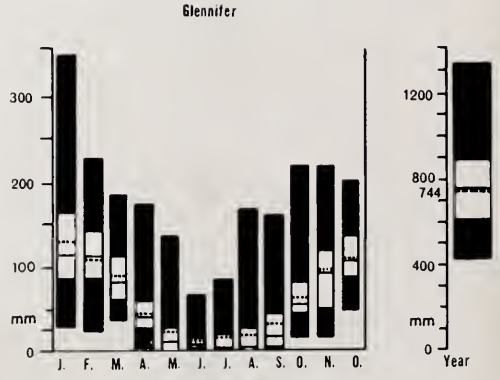


Photo. 104. Fynbos, chiefly of *Protea subvestita* (broad leaves), *Erica caffrorum* and *Cliffortia nitidula*, in eastern Highlands Region. Ntshiza, Qudeni, overlooking Valley Region in background. 5,700 ft. 5/12/57.

Photo. 105. View of *Cliffortia nitidula* Fynbos and invasion by the forest precursor, *Buddleia salviifolia* (light coloured shrubs next to figure). Eastern Highlands Region. Rocky ridge west of Qudeni beacon 88. ca. 5,700 ft. 5/12/57.

Photo. 106. Cliffortia nitidula Woodland, which has escaped burning on scree slope, the only such community that has been found in the Tugela Basin, though shrub communities are frequent (see Photo. 105). Eastern Highlands Region, Madhlosi mountain, Qudeni-Nqutu road. 5,400 ft. 6/12/57.

Photo. 107. Mountain *Podocarpus* Forest precursor scrub development amongst boulders where protected from fire. Species include: *Ekebergia capensis, Diospyros whyteana, Heteromorpha trifoliata, Canthium mundtianum, Maytenus undatus, Myrsine africana, Rhoicissus tridentata* and many others. Burnt *Buddleia salviifolia* precursor shrubs amongst rocks in foreground. Note fire-swept grassland on flat summit of hill. North aspect of hill above Dundee reservoir. 5,200 ft. 26/11/55.

Photo. 108. Developing initial forest clump amongst boulders, which has been destroyed by fire in *Protea* Savanna. *Podocarpus latifolius* tree on left is dead, whereas centre specimen has been severely damaged. The forest precursor, *Cussonia spicata*, has been relatively unaffected. Royal Natal National Park. ca. 5,000 ft. 25/1/55.

Photo. 109. Part of extensive Mist Belt Mixed *Podocarpus* Forest, showing retreating lower margins and replacement by fire maintained *Themeda* Grassland and Secondary *Aristida junciformis* Grassland. See also Photo. 23 for lower Semi-coast Forest extensions taken also from this point. Qudeni Forest and upper Mfongosi River.

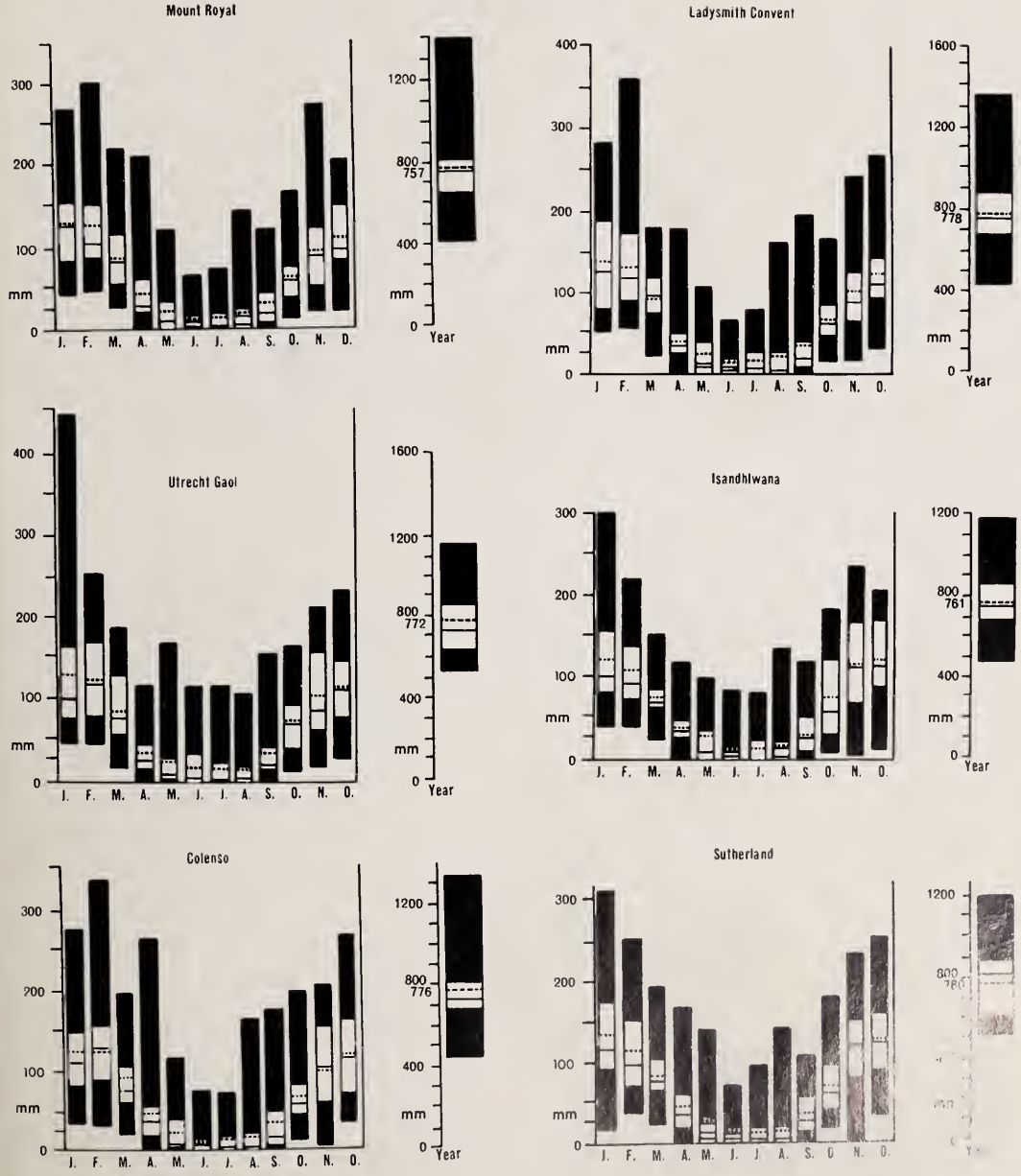
Photo. 110. View of relatively large patch of Mountain *Podocarpus* Forest below Cave Sandstone cliffs, with *Protea* Savanna and small forest patches amongst scattered boulders, below small cliff lines and along streams in foreground and middle distance. Gudu Forest, Royal Natal National Park. ca. 5,500 ft. 8/11/54.

Photo. 111. Interior of Mountain *Podocarpus* Forest. Large tree at right is *Podocarpus latifolius*, and field layer society is dominated by *Begonia sutherlandii*. Gudu Forest, Royal Natal National Park. ca. 5,500 ft. 20/1/55.

FIG. A2(Cont.)

INTERIOR BASINS

701-800 mm



PE/12

FIG. A2 (Cont.)

INTERIOR BASINS

701-800 m.m.

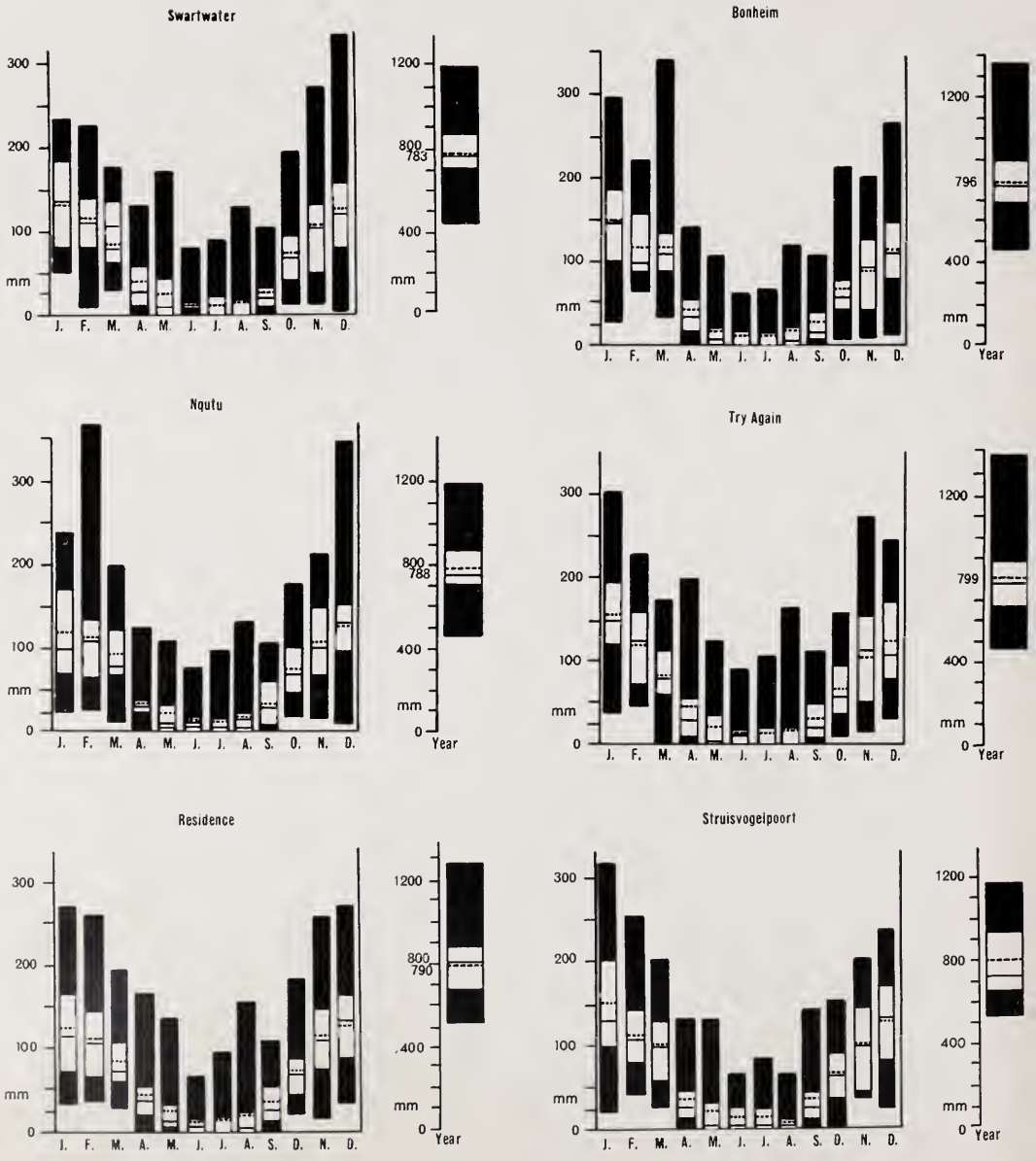


FIG. A2 (Cont.)

INTERIOR BASINS

801-1000 mm

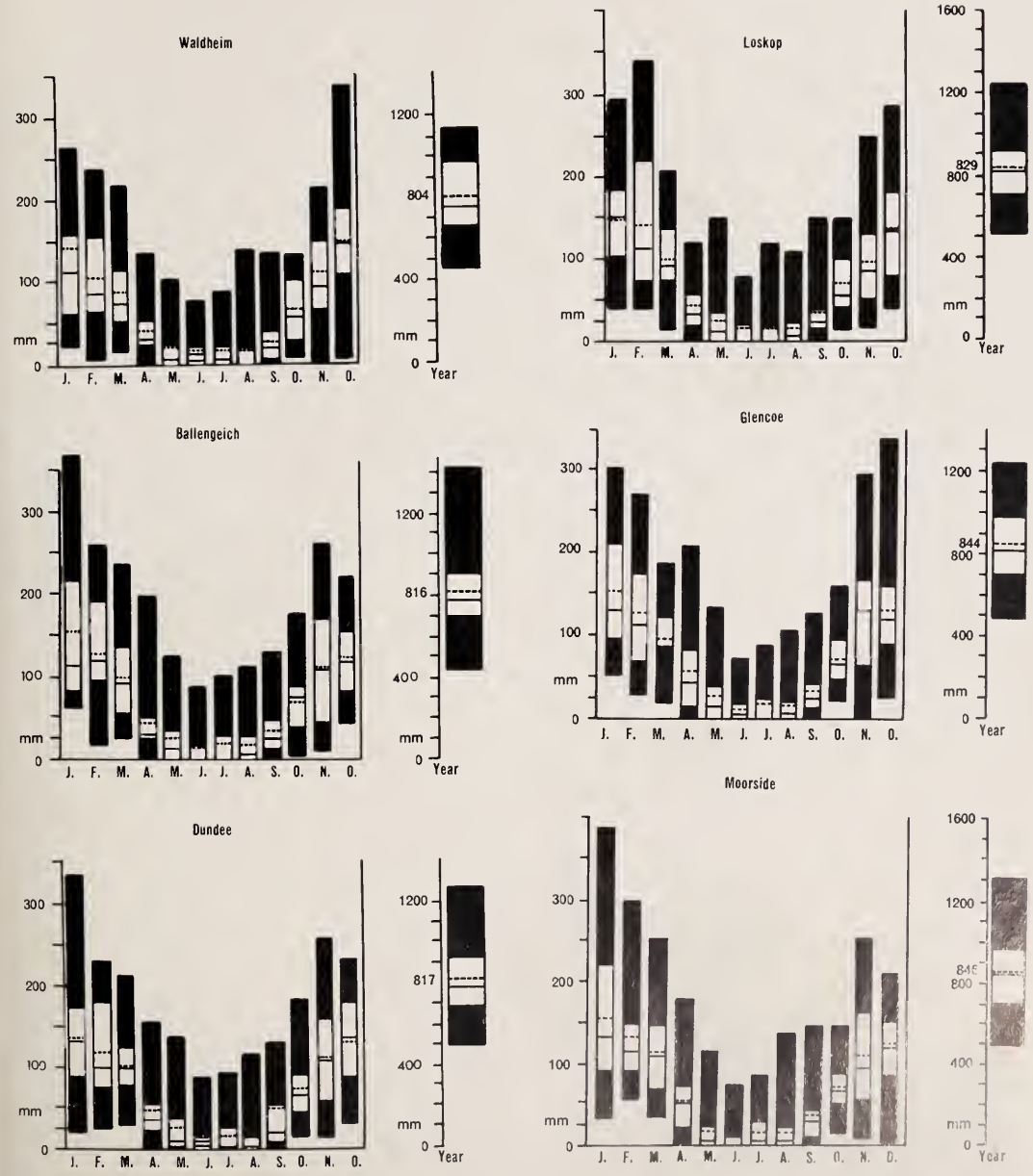


FIG. A2(Cont.)

INTERIOR BASINS

801-1000 mm

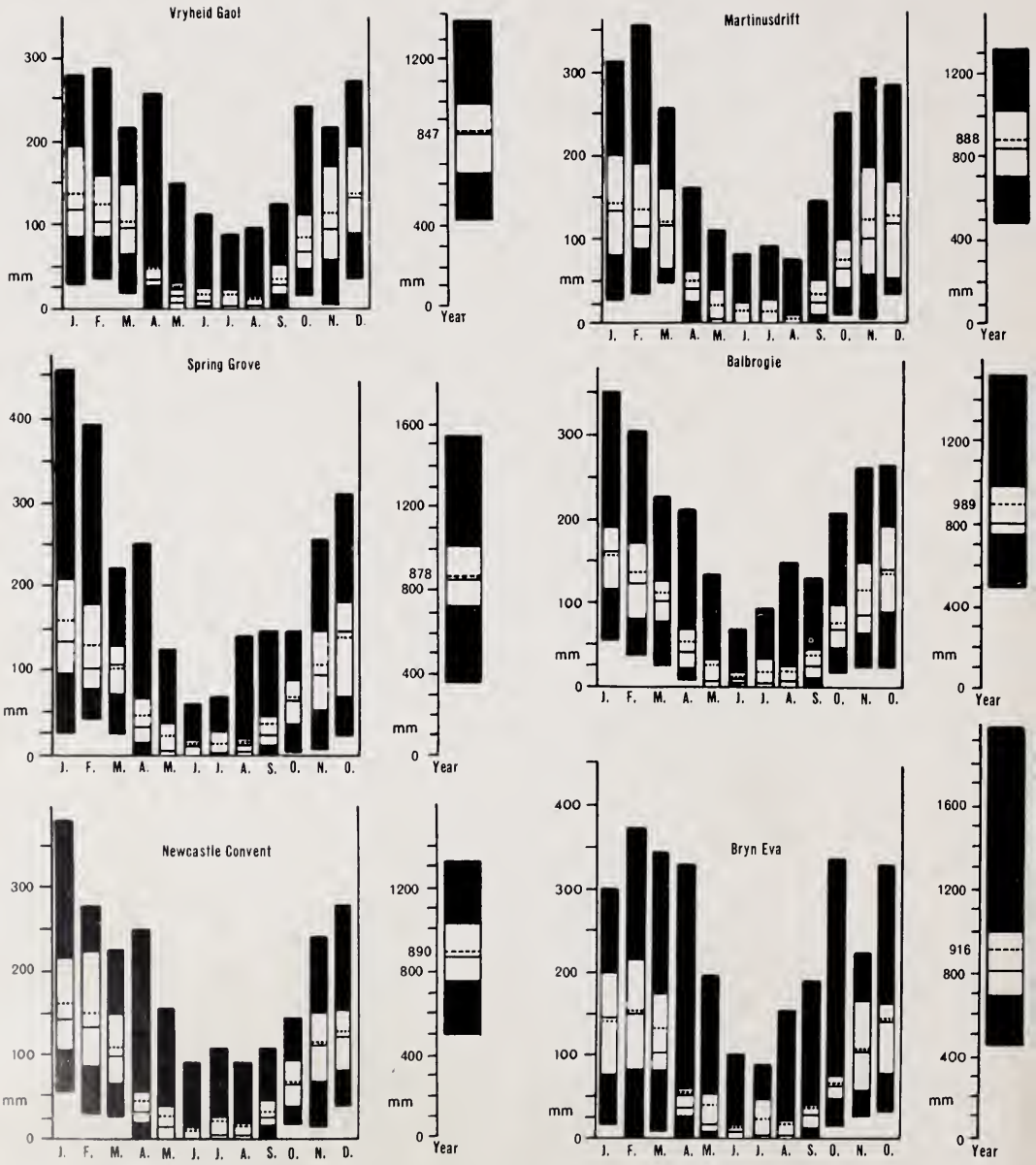
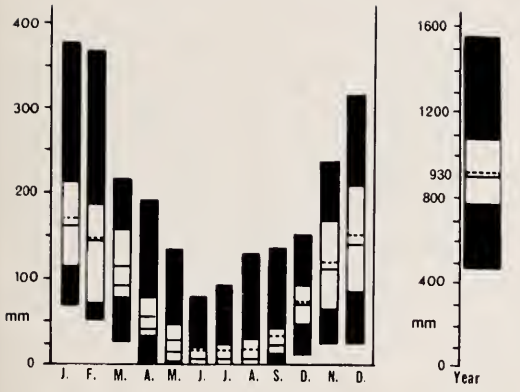


FIG. A2(Cont.)

INTERIOR BASINS

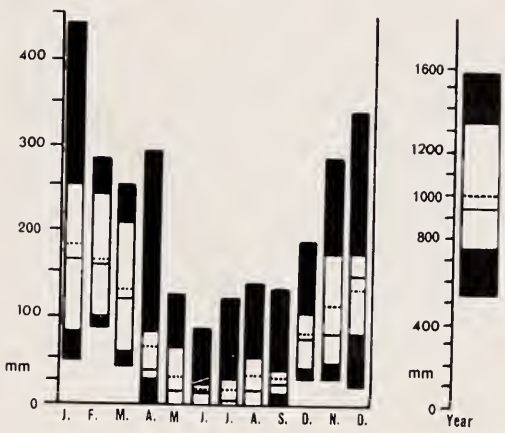
801-1000 mm

Mon Repos



801-1000 mm

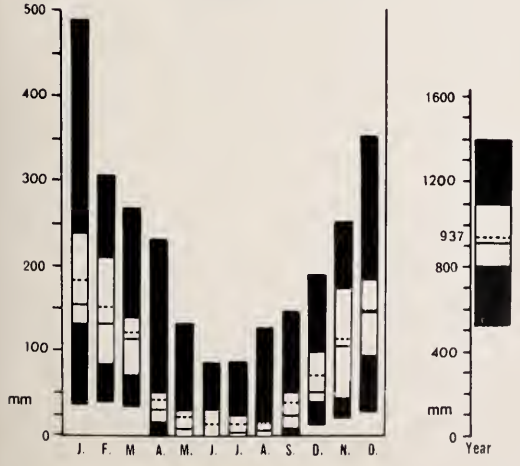
Geluksberg



MIDLAND MIST BELT

801-1000 mm

Hampton



Kromberg Estate

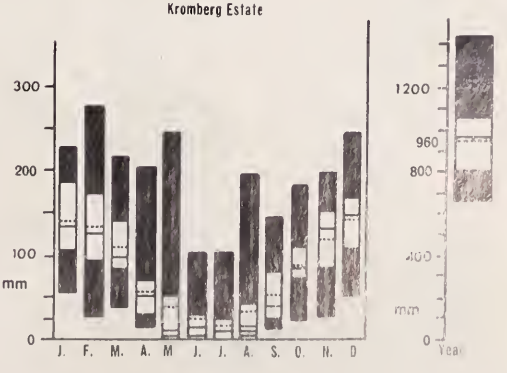
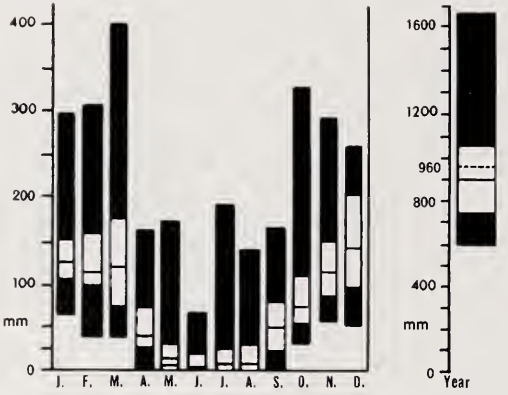


FIG. A 2(Cont.)

MIDLAND MIST BELT

801-1000 mm

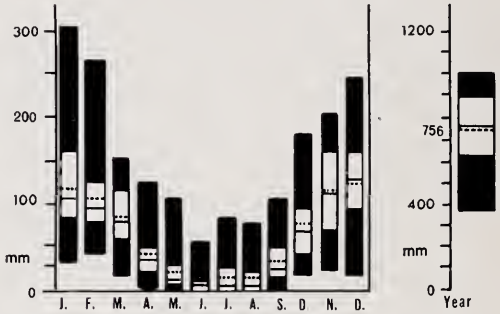
Greytown



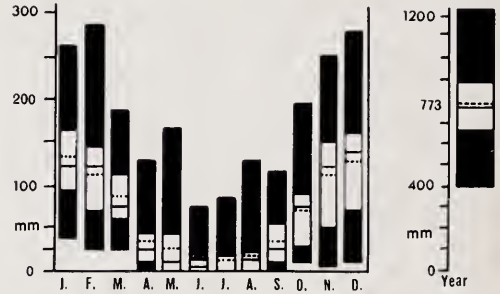
HIGHLANDS

701-800 mm

Wakkerstroom



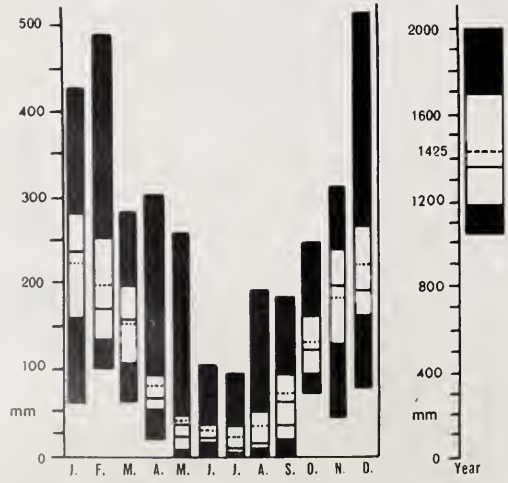
Helpmekaar



1001-1250 mm No Stations

1251-1500 mm

Woodlands



Glendoone

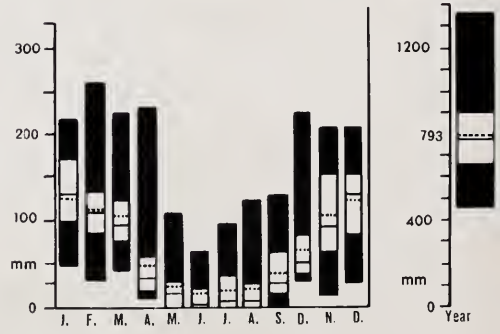


FIG. A2(Cont.)

HIGHLANDS

801-1000 mm

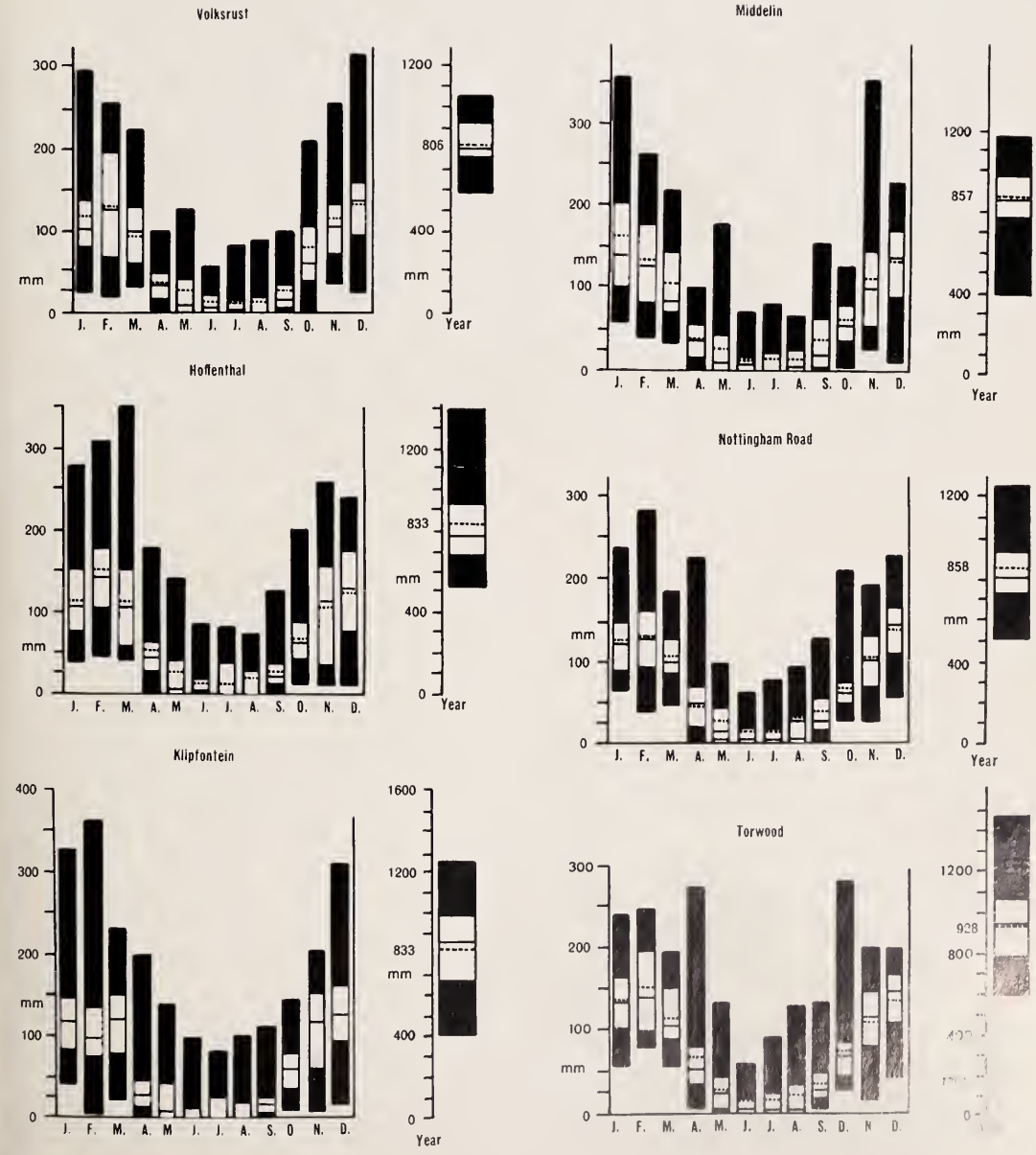
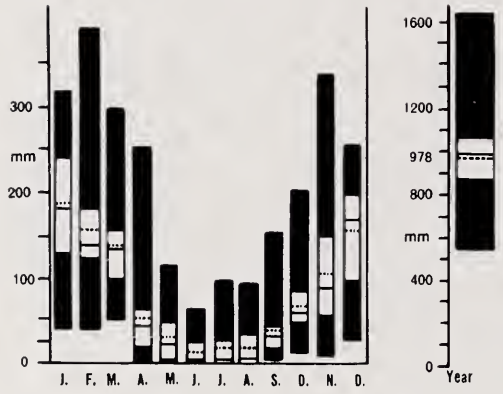


FIG. A2(Cont.)

HIGHLANDS

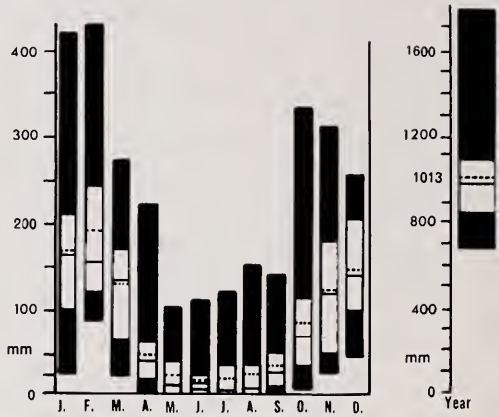
801-1000 mm

East Meshlyn



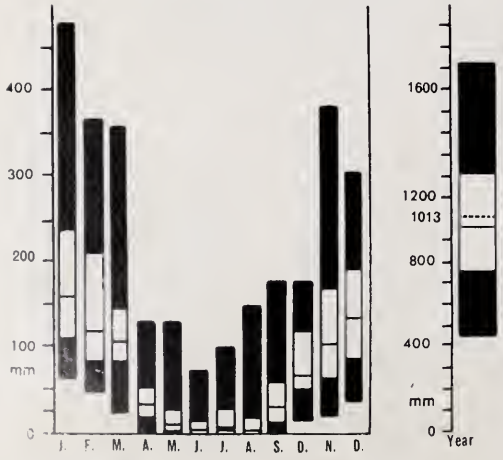
1001-1250 mm

Clifford Chambers



1001-1250 mm

Van Reenens Pass



1001-1250 mm

Munro's Winkel

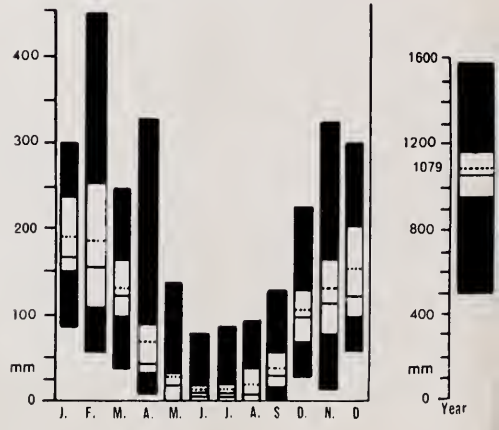


Photo. 112. Dense subclimax Mountain *Podocarpus* Forest, with abundant epiphytic Bryophyta. Trees shown include *Podocarpus latifolius*, *Diospyros whyteana*, *Kiggelaria africana* and the climber, *Clematis brachiata*. Stream boulder bed, Ndema Forest, Cathkin Park. c. 4,200 ft. 13/12/61.

Photo. 113. General view of Mountain *Podocarpus* Forest showing dominance of *Podocarpus latifolius* (left and centre) and *Olinia emarginata* (right). Normandien Forest Reserve. Newcastle district. c. 5,400 ft. 13/12/58.

Photo. 114. Pure stand of *Podocarpus latifolius* containing 64 saplings and trees, up to 40 ft high, in a 30 x 30 ft plot. Gudu Forest, Royal Natal National Park. c. 5,600 ft. 19/1/55.

Photo. 115. Retreating margin of Mountain *Podocarpus* Forest due to fire, showing burnt, dead trees and absence of seral, marginal scrub. Royal Natal National Park. 5,000 ft. 10/8/54.

Photo. 116. General view showing *Themeda-Tristachya-Digitaria* Northern Highlands Grassland, scrub-forest in foreground valley, and extensive, probably secondary, *Leucosidea sericea* Scrub. Near Majuba, Volksrust area. ca. 5,900 ft.

Photo. 117. General view showing Subalpine *Themeda-Festuca* Grassland in foreground and on mountain slopes below upper basalt cliffs, which form the transition to the summit Alpine Belt of vegetation. Peaks from left to right are Champagne Castle (part of escarpment) Monk's Cowl, Cathkin Peak (10,438 ft) and Sterkhorn. The last three peaks are separated from the main escarpment. 17/7/56.

Photo. 118. Fire-break in Subalpine *Themeda-Festuca* Grassland, showing relatively low basal cover in burnt portion and coarse, tussock character of unburnt grassland. Contour path below Cathkin Peak. c. 7,200 ft. 17/7/56.

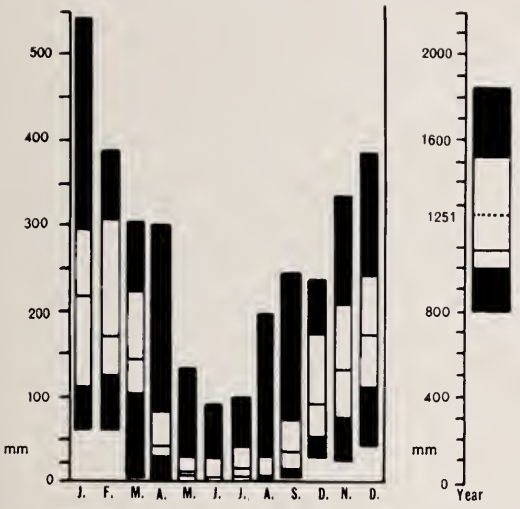
Photo. 119. Subalpine herbaceous vlei community of *Galtonia candicans*, *Plectranthus calycinus*, *Anemone fanninii* and many other species. Crescent-shaped erosion scars in Subalpine Grassland in background. Near New Sentinel Path, Royal Natal National Park. c. 7,000 ft. 2/2/55.

FIG. A2(Cont.)

HIGHLANDS

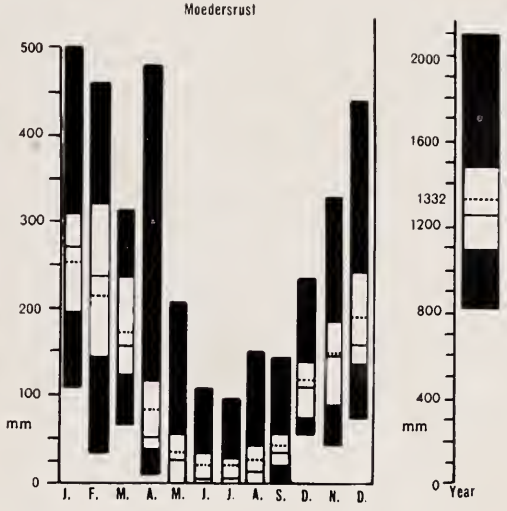
1251-1500 mm

Grosvenor Downs



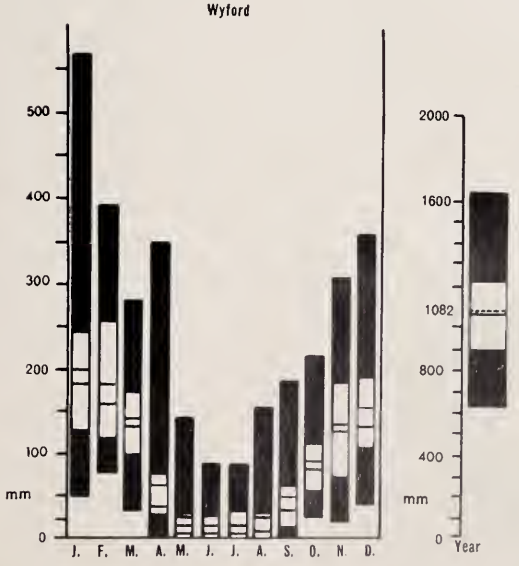
1251-1500 mm

Moedersrust



1001-1250 mm

Wyford



APPENDIX 2

SPECIES LIST

The following represents a list of species collected and recorded during the survey of the Tugela Basin. The list may be regarded as comprehensive for trees and shrubs, grasses are fairly well represented, whereas herbs, ferns and other plants are comparatively poorly represented.

Families and genera are arranged as in Phillips (1951) based on de Dalla Torre and Harms (1900–1907), and ferns as in Alston and Schelpe (1952) based on Christensen (1938). For convenience, the species are arranged in alphabetical order. The numbers after species refer to the author's collecting numbers. A few notes are given concerning the taxonomic features of some species.

Because of the considerable number of plant name changes in recent years, the former names of many familiar plants have been given in brackets *after* the new name. Where the new name has only recently come to hand, and has not been used in the text, the older name is given in brackets *before* the new name.

PTERIDOPHYTA

Lycopodiaceae

Lycopodium cernuum L. 2320.
L. clavatum L. 2321.

Selaginellaceae

Selaginella dregei (Presl) Hieron.
S. kraussiana (Kunze) A.Br.
S. mittenii Bak.

Equisetaceae

Equisetum ramosissimum Desf.

Schizaeaceae

Aneimia dregeana O. Ktze. 2103.
Mohria caffrorum (L.) Desv.

Gleicheniaceae

Gleichenia polypodioides (L.) Smith 507.
Sticherus umbraculiferus (Kunze) Ching. 551.

Cyatheaceae

Cyathea capensis (L.f.) Sm.
C. dregei Kunze.

Polypodiaceae

Dennstaedtioideae

Hypolepis sparsisora Kuhn. 2109.

Pteridioideae

Pteridium aquilinum (L.) Kuhn.
Pteris catoptera Kunze. 2687.

Gymnogrammeoideae

Adiantum thalictroides Willd. 2686.
Notholaena eckloniana Kunze. 1068.
Pellaea calomelanos (Sw.) Link. 1067.
P. quadripinnata (Forsk.) Prantl. 535.
P. viridis (Forsk.) Prantl. 1926.

Asplenioideae

Asplenium kraussii Moore ex Hook. 2494.

Dryopteridoideae

Dryopteris pentheri (Krass.) C. Chr. (*D. elongata* (Sw.) Sim). 534.
Polystichum ammifolium (Poir.) C. Chr. 325.
P. lucidum (Burm.) Becherer. 851, 2145.

Asplenioideae

P. luctuosum Moore. 2685.
Cyrtomium caryotideum (Wall.) Presl var. *micropteron* (Kunze) C. Chr. 2684.

Polypodioideae

Polypodium ecklonii Kunze. 494.
Phymatodes scolopendria (Burm.) Ching. 1734.

GYMNOSPERMAE

Cycadaceae

Encephalartos ghellinckii Lem.

Taxaceae

Podocarpus falcatus R. Br. 503.
P. henkelii Stapf. 504.
P. latifolius R. Br.

Pinaceae

Widdringtonia dracomontana Stapf. 2125.

ANGIOSPERMAE
MONOCOTYLEDONEAE

Typhaceae

Typha capensis Rohrb.

Potamogetonaceae

Potamogeton octandrus Poir. (*P. panormitanus* Biv.). 2342.

P. trichoides Cham. & Schlechtd. 3132
P. thunbergii Cham. & Schlechdt. (*P. nodosus* Poir.). 2408, 2752, 2698, 3119 and 3218.

APONOGETONACEAE

Aponogeton natalensis Oliv. 2675.
A. spathaceum Hook.f. 2384, 2432.

HYDROCHARITACEAE

Lagarosiphon major (Ridley) Moss. 2369.
L. muscoides Harv. 2409, 2697, 2699, 3102, 3123.

GRAMINEAE

Imperata cylindrica (L.) Beauv. 667.
Eriochrysis pallida Munro. 2242.
Miscanthidium capense (Nees) Stapf. 474.
M. capense (Nees) Stapf var. *villosum* (Stapf) Phillips 1257.
M. junceum (Stapf) Stapf. 2053.
Eulalia villosa (Thunb.) Nees. 487, 1296, 1321.
Ischaemum franksiae J. M. Wood. 385, 389.
Urelytrum squarrosum Hack. 1039, 1642.
Hemarthria altissima Stapf et C. E. Hubbard. 2037, 2422.
Trachypogon spicatus (L.). O. Ktze. (*T. plumosus* Nees) 518, 561, 562, 563, 672, 683, 1955.
Elyonurus argenteus Nees. 330, 638, 2463.
Andropogon abyssinicus R. Br. 2819.
A. amplectens Nees. 661, 1234, 1297, 1920.
A. appendiculatus Nees. 525, 537, 566, 628, 1037, 1046, 1132, 1970.
A. distachyus L. 2006.
A. eucomus Nees. 2262, 2378.
A. filifolius (Nees) Steud. 329, 386, 564, 630, 639, 1935, 1954.
A. schirensis Hochst. 624, 673.
A. schirensis Hochst. var. *angustifolius* Stapf. 1298.
A. sp. cf. *A. pratensis* Hochst. 2133.
A. sp. nov. 1148.
Sorghum halepense (L.) Pers. 1722.
S. versicolor Anderss. 668.
S. verticilliflorum (Steud.) Stapf. 1212.
Bothriochloa glabra (Roxb.) A. Camus. 778, 1293, 2052.
B. insculpta (Hochst.) A. Camus. 712, 1239, 1490, 1901.
Dichanthium aristatum (Poir.) C. E. Hubbard. 1415, 1416.
D. papillosum (Hochst.) Stapf. 3057.
Schizachyrium semiberbe Nees. 1302.
Cymbopogon excavatus (Hochst.) Stapf. 1323, 2040.
C. plurinodis Stapf. 711, 1250.
C. validus Stapf ex Burtt Davy. 531, 680, 1133, 1326, 1914.
Hyparrhenia aucta (Stapf) Stent. 663, 1399.
H. cymbaria (L.) Stapf. 1304, 1317.
H. filipendula (Hochst.) Stapf. 3011.
H. glauca Stent. 2032, 2019, 769, 2048.
H. hirta (L.) Stapf. 453, 634, 662, 754, 1258, 1400, 2029, 2184, 2265.
Monocymbium ceresiiforme (Nees) Stapf. 539, 625.
Heteropogon contortus (L.) Beauv. 559, 577.
Themeda triandra Forsk. 369, 632, 710, 1721, 1957, 1971.
T. triandra Forsk. var. *trachyspathea* Goossens. 1909.
Perotis patens Gandoger. 1361, 1899.
Arundinella nepalensis Trin. 784, 849, 2017, 2113.
Melinis minutiflora Beauv. 684.
Paspalum commersonii Lam. 456, 1665, 2392.
P. dilatatum Poir. 2394.
P. distichum L. 1889, 2045, 2057, 2530.
P. urvillei Steud. 1230.
P. vaginatum Sw. 1727.
Panicum aequinerve Nees. 532, 1322.
P. coloratum L. 3027.
P. deustum Thunb. 729.
P. ecklonii Nees. 379, 391, 1082, 2224.
P. maximum Jacq. 743, 1263, 2734.
P. natalense Hochst. 530, 626, 1053.
Alloteropsis semialata (R. Br.) Hitchc. 327, 448, 1052, 2228.
Urochloa mosambicensis (Hack.) Dandy. 707, 1219, 1249, 1842, 1877.
Brachiaria brizantha (Hochst.) Stapf. 1639, 1919.
B. eruciformis (Sibth. & Smith) Griseb. 1264.
B. filifolia Stapf. 1047, 2260.
B. serrata (Spreng.) Stapf. 454, 629.
Echinochloa crusgalli (L.) Beauv. 2393.
E. crus-pavonis (H.B.K.) Schult. 1289.
E. sp. 2386, 2395.
Sacciolepis curvata (L.) Chase. 1720, 1891, 2737.
Digitaria diagonalis (Nees) Stapf. 681, 1231, 1320.
D. diversinervis Stapf. 1763.
D. longiflora (Retz.) Pers. 1846, 2735.
D. macroglossa Henr. 708, 1592.
D. monodactyla (Nees) Stapf. 512, 519, 576.
D. pentzii Stent. 1248, 1637, 1912, 2733 (var.).
D. polevansii Stent. 1657.
D. setifolia Stapf. 2219, 2439.
D. swazilandensis Stent. 1555.
D. teruata (Hochst.) Stapf. 669, 1844.
D. tricholaenoides Stapf. 994, 1036, 1901, 2244.
D. sp. cf. *D. pentzii* Stent var. 2805.
Tricholaena monachne (Trin.) Stapf & C. E. Hubbard. 1904, 1907.
Rhynchelytrum repens (Willd.) C.E. Hubbard. 786, 1903

R. setifolium (Stapf) Chiov.
Oplismenus hirtellus (L.) Beauv. 1313.
Setaria chevalieri Stapf ex Stapf & C. E. Hubbard. 1702.
S. nigrirostris (Nees) Dur. & Schinz. 449, 1072, 2396.
S. pallide-fusca (Schumach.) Stapf & C. E. Hubbard. 445, 457.
S. sphacelata (Schumach.) Stapf & C. E. Hubbard. 1261, 1465, 1593, 1600, 1664, 1908, 1911, 3051.
S. verticillata (L.) Beauv. 721.
S. woodii Hack. 1217, 2185.
Pennisetum natalense Stapf. 1831, 2031.
P. thunbergii Kunth. 2191.
Beckeropsis uniseta (Nees) Stapf ex Robyns. 682, 783, 1500, 2038, 2043.
Stenotaphrum secundatum (Walt.) O. Ktze. 1561, 1725.
Leersia hexandra Sw. 1232, 1918, 2050, 2348, 2388, 2398.
Ehrharta longigluma C. E. Hubbard. 653, 1939, 1943, 1946.
Phalaris arundinacea L. 2419.
Anthoxanthum ecklonii (Nees) Stapf. 757, 606, 648.
Aristida barbicollis Trin. & Rupr. 621, 1236.
A. bipartita (Nees) Trin. & Rupr. 1225.
A. capensis Thunb. var. *barbata* Stapf. 1723.
A. curvata (Nees) Trin. & Rupr. 1237.
A. diffusa Trin. var. *burkei* (Stapf) Schweick. 800, 1255.
(*A. galpinii* Stapf) *A. junciformis* Trin. & Rupr. ssp. *galpinii* (Stapf) de Winter. 1966, 2366.
A. junciformis Trin. & Rupr. 631, 1238, 2021, 2436, 2521, 2837.
A. monticola Henr. 570, 642.
A. sciurus Stapf. 2049, 2051.
Stipa dregeana Steud. 467.
Sporobolus capensis (Willd.) Kunth. 1558.
S. centrifugus Nees. 1144, 1299, 1488, 1952, 1972, 2205.
S. centrifugus Nees var. *filifolius* Stent. 513, 574, 636.
S. fimbriatus Nees. 2042, 2739.
S. fimbriatus Nees var. *latifolius* Stent. 713, 1235, 2044.
S. pyramidalis Beauv. 623, 1910.
S. smutsii Stent. 715, 720, 1214, 1254.
S. stapfianus Gand. 618, 993.
S. virginicus (L.) Kunth. 1728, 1733.
Polypogon monspeliensis Desf. 2531.
Agrostis barbuligera Stapf. 608, 1145.
A. eriantha Hack. 458.
A. huttoniae (Hack.) C. E. Hubbard. 2193.
A. lachnantha Nees. 921, 1967, 2227, 2350.
A. subulifolia Stapf. 611, 1149.
Aira caryophyllea L. 654.
Helictotrichon hirtulum (Steud.) Schweickerdt. 452, 609, 644.
H. longifolium (Nees) Schweickerdt. 1147.
H. turgidulum (Stapf) Schweickerdt. 996, 1958, 1959, 2258.
H. sp. 655.
Tristachya hispida (L.f.) K. Schum. 387.
Trichopteryx dregeana Nees. 1300.
Loudetia simplex (Nees) C. E. Hubbard. 524, 1303, 1324.
L. sp. near *L. flavida* (Stapf) C. E. Hubbard. 2254.
Danthonia aureocephala J. G. Anderson 2132
D. disticha Nees. 594, 602, 1499, 1977.
D. drakensbergensis Schweickerdt. 364, 603, 1948, 1950, 2284.
D. macowanii Stapf. 843, 2158, 2453, 2673.
D. stereophylla J. G. Anderson. 347, 367.
Pentaschistis galpinii McClean. 599.
P. natalensis Stapf. 1330.
P. oreodoxa Schweickerdt. 590, 597, 652, 1938, 1975, 1985, 1986.
P. pilosogluma McClean. 1979, 2279.
P. tysonii Stapf. 332, 1981, 1983, 1984.
P. sp. 2140 (Probably sp. nov.)
Microchloa caffra Nees. 334.
Rendlia altera (Rendle) Chiov. (*R. nelsonii* (Rendle) Chiov). 331, 925.
Cynodon dactylon (L.) Pers. 1557.
Harpechloa falx. (L.f.) O. Ktze. 388.
Ctenium concinnum Nees. 1301.
Enteropogon simplex (Schumach. et Thonn.) A. Chev. 1641.
Chloris gayana Kunth. 1902.
C. pycnothrix Trin. 741, 1843.
C. virgata Sw. 742, 1220, 1252, 1878.
Dactyloctenium aegyptium (L.) Beauv. 2736.
D. australe Steud. 1355.
Enneapogon cenchroides (Licht.) C. E. Hubbard. 1251.
E. scoparius Stapf. 2068.
Triraphis andropogonoides (Steud.) Phillips. 2821.
Fingerhuthia africana Lehm. 1213.
Phragmites communis Trin. 2039.
Diplachne eleusine Nees. 1262, 1845.
Pogonarthria squarrosa (Licht.) Pilg. 627.
Trichoneura grandiglumis (Nees) Stapf & C. E. Hubbard. 1536.
Eragrostis caesia Stapf. 592, 641, 1941, 1960, 1961, 1962.
E. capensis (Thunb.) Trin. 311, 368, 390, 926.
Eragrostis chapelieri (Kunth) Nees. 1965.
E. chloromelas Steud. 633, 1011, 1012, 1013, 1865.
E. ciliaris (L.) R. Br. 1678, 1876.
E. curvula (Schrad.) Nees. 450, 990, 1227, 1888, 1906, 2023, 2197, 2243, 2462, 2738.

E. gummiflua Nees. 622.
E. heteromera Stapf. 620.
E. lappula Nees var. *divaricata* Stapf. 1048.
E. lappula Nees var. *lappula*. 619.
E. plana Nees. 1226.
E. planiculmis Nees. 451, 565, 2352, 2387, 2420.
E. racemosa (Thunb.) Steud. 441, 511, 558, 573, 989, 1035.
E. superba Peyr. 701, 709, 1535, 1640, 1900.
E. sp. 1038.
Koeleria cristata (L.) Pers. 333, 337, 366, 605, 640, 1937, 1956, 1968, 2223.
Stiburus alopecuroides (Hack.) Stapf. 637, 1331.
S. conrathii Hack. 927, 2222.
Poa binata Nees. 1965, 2171.
Festuca caprina Nees. 604, 643, 645, 1146, 1936, 1942, 1945, 1947, 1978, 1980.
F. costata Nees. 326, 1940, 1953, 1973, 2225, 2229, 2336.
F. killickii Kennedy-O' Byrne.
F. scabra Vahl. 1097, 1934, 2201.
F. sp. 601, 1974.
F. sp. nov. (Killick 1835, 2282). 2277.
Bromus speciosus Nees. 651, 2226.
Brachypodium bolusii Stapf. 646.
B. flexum Nees. 544.
Arundinaria tessellata (Nees) Munro.
Brachiaria filifolia Stapf. 1047, 2260.

CYPERACEAE

Ascolepis capensis Ridley. 2159, 2435.
Cyperus albostriatus Schrad. 1565.
C. articulatus L. 2060.
C. compactus Lam. 1104, 1556.
C. compactus Lam. var. *flavissimus* C.B. Cl. 438.
C. denudatus L. f. 1124, 2429.
C. esculentus L. 1683.
C. fastigiatus Rottb. 2391, 2417.
C. immensus C.B. Cl.
C. latifolius Poir. 2206.
C. littoralis Schrad. 2830.
C. margaritaceus Vahl. 3029.
C. marginatus Thunb. 2030, 2036, 2058, 2346.
C. natalensis Hochst. 1741, 1757.
C. semitrifidus Schrad. 309, 1098.
C. sexangularis Nees. 914.
C. sphaerospermus Schrad. 2257, 2390.
C. teneriffae Poir. 1247.
C. sp. 2280.
Pycreus macranthus (Boeck.) C.B. Cl. 1042, 2196, 2202, 2351, 2389, 2401, 2428.
P. mundtii Nees. 901, 920, 2189, 2415.
P. oakfortensis C.B. Cl. 1126, 2434.
P. polystachyus Beauv. 1756.
P. umbrosus Nees. 924.
Mariscus congestus C.B.Cl. 1125, 2381.
M. dregeanus Kunth. 1760.
Kyllinga aurata Nees. 1759, 2442.
K. melanosperma Nees. 2190, 2357.
Ficinia cinnamomea C.B. Cl. 335.
F. gracilis Schrad. 515.
F. stolonifera Boeck. 2376.
F. sp. 2221.
Fuirena pubescens Kunth. 315, 1044, 2194, 2261, 2354, 2403.
Scirpus falsus C.B. Cl. 342, 352, 499, 600.
S. fluitans L. 2237, 2427, 2430.
S. inclinatus (Del.) Aschers. & Schweinfurth. 1229, 2411.
S. littoralis Schrad. 2830.
S. macer Boeck. 2192.
S. muricinux C.B. Cl. 1049.
S. paludicola Kunth. 2345, 2347.
S. setaceous L. 607.
Eleocharis dregeana Steud. (*E. palustris* R. Br.) 1050, 2349, 2385.
E. sp. 2198.
Fimbristylis complanata (Retz.) Link. 1043, 2195, 2259, 2353, 2362, 2364, 2368, 2377, 2382, 2400, 2412.
F. dichotoma (L.) Vahl. 2379, 2380.
F. ferruginea (L.) Vahl. 1726.
F. hispidula (Vahl) Kunth. 1680.
Fimbristylis monostachya (L.) Hassk. 1599.
F. obtusifolia Kunth. 1758.
Bulbostylis collina (Kunth) C.B. Cl. 1742, 1890.
B. oritrephes (Ridley) C.B. Cl. 434, 446.
B. schoenoides Kunth. 2210, 2404, 2438.
Tetraria cuspidata C.B. Cl. 579, 2014, 2138.
Scleria welwitschii C.B. Cl. 1127.
S. woodii C.B. Cl. 2405.
Schoenoxiphium caricoides C.B. Cl. 2208.
Carex zuluensis C.B. Cl. 466, 529.
C. sp. cf. *C. clavata* Thunb. 2160.
C. sp. cf. *C. coguata* Kunth. 2418.

PALMAE

Phoenix reclinata Jacq.
Hyphaene crinita Gaertn.

ARACEAE

Zantedeschia aethiopica Spreng.
Z. albomaculata Baill.

LEMNACEAE

Wolffia arrhiza (L.) Wimm. 2813.

FLAGELLARIACEAE

Flagellaria guineensis Schum. 1772.

RESTIONACEAE

Restio sp. 509.

XYRIDACEAE

Xyris capensis Thunb. 2498.

ERIOCAULACEAE

Eriocaulon abyssinicum Hochst. 2496.

COMMELINACEAE

Commelina africana L. 1656.
Aneilema aequinoctiale Kunth. 1839.
A. schlechteri K. Schum. 1624, 1838.
Cyanotis nodiflora Kunth. 1101.

PONTEDERIACEAE

Eichornia crassipes Solms. Introduced.

JUNCACEAE

Juncus effusus L. 2414, 2437.
J. exsertus Buchen. 2344.
J. maritimus Lam. 1755.
J. oxycarpus E. Mey. 2363, 2413.
J. punctorius L. 2343.
J. suboxycarpus Adamson. 2421.

LILIACEAE

Wurmbea sp. near *W. kraussii* Bak. 1165.
Bulbine asphodeloides L. 2806.
B. narcissifolia Salm-Dyck. 992, 2764.
Trachyandra capillata (Poelln.) Oberm. 3025.
T. gerrardii (Bak.) Oberm. 420.
T. saltii (Bak.) Oberm. var. *saltii*. 1180.
Kniphofia caulescens Bak. 2292, 2294.
K. sp. cf. *K. parviflora* Kunth. 2299.
K. sp. nov. (Killick 1857) 1186, 2290, 2297.
K. sp. 2301.
Aloe arborescens Miller. 1487.
A. bainesii Th. Dyer.
A. boylei Bak.
A. candelabrum Berger.
A. marlothii Berger.
A. mudenensis Reynolds. 2843, 2845.
A. rupestris Bak.
A. saponaria (Ait.) Haw.
A. spectabilis Reynolds.
A. sp. 1096.
Agapanthus natalensis Leighton. 1130.
Tulbaghia leucantha Bak. 308.
T. natalensis Bak. 2174.
T. sp. 307.
Albuca sp. cf. *A. pachychlamys* Bak. 306.
Galtonia candicans Decne. 542, 555, 1175.
Scilla carnosula v.d. Merwe. 1598.
S. kraussii Bak. 2165.
S. natalensis Planch. 975.
S. sp. 314.
Eucomis bicolor Bak. 568, 1191.
E. humilis Bak. 1169.
E. sp. 1128.
Ornithogalum zeyheri Bak. 1418, 2079.
Dracaena hookeriana K. Koch. 1748.
Asparagus falcatus L. 295, 922, 1685, 1774.
A. rivalis Kies. 962.
A. sp. 940.
Behnia reticulata F. Didrichs. 1105, 2689.
Smilax kraussiana Meisn. 1447, 1572.
Elsiea flanaganii (Bak.) Leighton. 1184.

AMARYLLIDACEAE

Clivia miniata Lindl.
Brunsvigia undulata Leighton. 526.
Anoigantlus breviflorus Bak. 1417, 2172.
Apodolirion sp. 2715.
Crinum macowanii Bak. 939.
Ammocharis falcata Herb. 991.
Cyrtanthus flanaganii Bak. 350, 2282.
Hypoxis rooperi Moore. 2407.
Rhodohypoxis baurii (Bak.) Nel. 339, 2169.
R. palustris Killick. 2676.

VELLOZIACEAE

Vellozia retinervis Bak.
V. talbotii Balf. 2691.
V. viscosa Bak.

DIOSCOREACEAE

Dioscorea cotinifolia Kunth. 1607, 1817.
D. dregeana (Kunth) Dur. & Schinz. 2664.
D. sylvatica Eckl. 693.

IRIDACEAE

Moraea natalensis Bak. 2168.
M. spathulata Klatt. 2207.
Dietes butcheriana Gerstner. 2638.
Hesperantha baurii Bak. 3068.
H. longituba Bak. 2750.
Dierama medium N.E. Br. 1181.
D. trichorhizum N.E. Br. 2677.
Crocosmia aurea Planch. 2478.
Gladiolus longicollis Bak. 1188.
G. papilio Hook. f. 2423.
Watsonia densiflora Bak. 2286.

MUSACEAE

Strelitzia nicolai Regel and Koch.

ORCHIDACEAE

Stenoglottis fimbriata Lindl. 2483.
Huttonaea grandiflora Rolfe. 2751.
Satyrium cristatum Sond. 1167.
S. longicauda Lindl. 1129.
S. neglectum Schltr. 567.
Disa chrysostachya Swartz. 2433.
D. stachyoides Reichb. f. 1168.
Herschelia baurii Kranzl. 2157.
Polystachya ottoniana Reichb. f. 956.
P. sandersonii Harv. 1522.
Ansellia gigantea Reichb. f.
Eulophia foliosa H. Bolus. 1090.
E. zeyheri Hook. f. 442, 443, 2406.
Cyrtorchis arcuata (Lindl.) Schltr. 1779, 2740.

DICOTYLEDONEAE

PIPERACEAE

Piper capense L. 2322.
Peperomia reflexa A. Dietr.

SALICACEAE

Salix woodii Seem. 402, 2033, 2034, 2035, 2054, 2059.

MYRICACEAE

Myrica serrata Lam. 850.
M. pilulifera Rendel. 1484, 2005.

ULMACEAE

Celtis africana Burm. f. (*C. kranssiana* Bernh.) 397, 773, 774, 780.
Trema orientalis (L.) Bl. 1292, 1483.
Chaetacme aristata Planch. 836.

MORACEAE

Ficus burkei Miq. 986.
F. burtt davyi Hutch. 686, 702, 954.
F. capensis Thunb. 840, 876, 909, 1295.
F. capreaefolia Dil.
F. ingens Miq. 685, 839, 987, 1425, 2075, 2124, 2445, 2448, 2450 and 2510.
F. natalensis Hochst. 1542.
F. petersii Warb. 801, 1714, 1847, 2355, 2444.
F. pretoriae Burtt Davy. 908, 2267, 2446, 2447, 2449.
F. soldanella Warb.
F. sonderi Miq. 1286, 1288, 1693, 1695, 2268.
F. sycamorus L.

URTICACEAE

Urera tenax N.E. Br.

PROTEACEAE

Faurea macnaughtonii Phillips. 1468, 2085.
Protea dracomontana Beard. 505, 508, 2012.
P. gaguedi Gmel.
P. multibracteata Phillips. 2181, 2183, 2365.
P. rouppelliae Meisn. 304, 2111.
P. subvestita N.E. Br. 506, 516, 1999, 2004, 2114, 2234, 2306, 2307.

LORANTHACEAE

Loranthus dregei E. & Z. 779.
L. minor Sprague. 1615, 2669, 2844.
L. subcylindricus Sprague. 1432.
L. zeyheri Harv. 298, 1009, 2264.
L. sp. cf. *L. minor* Sprague. 2508.
Viscum rotundifolium L. f. 736, 2762.
V. viscosum Harv. 1932, 1933.

SANTALACEAE

(*Osyris compressa* (Berg.) A. DC.) *Colpoon compressum* Berg. 462, 2460.
Thesium acutissimum A. DC. 1143.
T. asterias A. W. Hill. 520.
T. racemosum Bernh. 356.
T. rasum (A. W. Hill) N.E. Br. 1138.
T. sp. 1662.

OLACACEAE

Ximenia caffra Sond. var. *natalensis* Sond. 791, 1578.

POLYGONACEAE

Rumex lanceolatus Thunb. 421.
Polygonum lapathifolium L. 2041.
P. lapathifolium L. var. *maculatum* Dyer & Trin. 1233.
P. pulchrum Blume. 2397.
P. salicifolium Brouss. 2410, 2753.
P. strigosum R. Br. 2416.

AMARANTACEAE

Pupalia atropurpurea Moq. 1765.
P. lappacea (L.) Juss. 1821.
Achyranthes aspera L. 1855.
Achyropsis leptostachya Hook. f. 1854.

NYCTAGINACEAE

Commicarpus pentandrus (Burch.) Heim. 1241.
(*C. plumbagineus* (Cav.) Standley). *C. africanus* (Lour.) Cuf. 1820.

PHYTOLACCACEAE

Limeum viscosum (Gay.) Fenzl. ssp. *viscosum* var. *kranssii* Friedr. 1676, 1684.
Psammatropha alternifolia Killick. 615, 1136.
P. mucronata (Thunb.) Fenzl. var. *mucronata*. 2281.

AIZOACEAE

Hypertelis salsoloides (Burch.) Adamson. 3054.

Trianthema transvaalensis Schinz. 718.
Aptenia cordiifolia (L. f.) Schwant. 2776.
Carpobrotus acinaciformis (L.) N.E. Br.
Delosperma sutherlandii (Hook. f.) N.E. Br. 2679.
D. tradescantioides (Bgr.) L. Bol. 2777, 3015.
D. sp. 1704.

PORTULACACEAE

Portulacaria afra Jacq. 932.

CARYOPHYLLACEAE

Pollichia campestris Ait. 3052.
Dianthus sp. 433, 647.

RANUNCULACEAE

Anemone fanninii Harv. 580, 2128.
Clematis brachiata Thunb. 393, 679, 692, 745, 1268.
Ranunculus multifidus Forsk. 2238, 2441.

MENISPERMACEAE

Antizoma angustifolia (Burch.) Miers ex Harv. 2809.
Cissampelos torulosa E. Mey. 498.
Hyalosepalum caffrum (Miers) Troupin. 1771.

ANNONACEAE

Uvaria caffra E.Mey. 297, 1364, 1634, 1762.
Popowia caffra Hook.f. & Thoms. 1577.

MONIMIACEAE

Xymalos monospora Baill. 834, 1112, 1377.

LAURACEAE

Cryptocarya latifolia Sond. 1434.
C. woodii Engl. 476, 1066, 1566.
Cassytha sp. 2641.

CRUCIFERAE

Lepidium africanum (Burm.) DC. 432.

CAPPARIDACEAE

Capparis citrifolia Lam. 727, 882.
C. tomentosa L. 278.
C. transvaalensis Schinz var. *calvescens* (Gilg & Benedict) comb. nov. 1917, 2526, 2785, 3033, 3035.
Boscia albitrunca Gilg & Benedict. 915.
Cadaba natalensis Sond. 3034.
Maerua angolensis DC. 806, 1209.
M. caffra (DC.) Pax. 2525.
M. rosmarinoides (Sond.) Gilg & Benedict. 1806.
Bachmannia woodii (Oliv.) Gilg 1439, 2327.

PODOSTEMACEAE

Tristicha trifaria Spreng. 1412, 2825.
Sphaerothylax algiformis Bischof. 2814.

CRASSULACEAE

Cotyledon orbiculata L. 923, 2452.
Kalanchoe paniculata Harv. 2807.
K. rotundifolia Harv. 2070.
K. thyrsiflora Harv. 2139.
Crassula harveyi Br. & Bak.f. 2144?, 2278?
C. lineolata Dryand. 1837.
C. natans Harv. 2497.
C. setulosa Harv. 1139 (var.).

PITTOSPORACEAE

Pittosporum viridiflorum Sims. 242, 254, 377, 400, 1606.

CUNONIACEAE

Cunonia capensis L. 1335.

ROSACEAE

Rubus cuneifolius Pursh. 2695. Introduced.
R. rigidus Smith var. *mundtii* (Cham. & Schlechtd) Focke. 396, 2211. Introduced.
Leucosidea sericea E. & Z. 255, 772.
Cliffortia browniana Burtt Davy. 596, 2013.
C. linearifolia E. & Z. 244, 928, 976.
C. nitidula (Engl.) A. E. & T. C. E. Fries ssp. *pilosa* Weim. 2235, 2248, 2456?
C. repens Schltr. 2233.
Pygeum africanum Hook.f. 483, 2642, 2670, 2840.

CONNARACEAE

Cnestis natalensis Planch. & Sond. 2309.

LEGUMINOSAE

Albizia adianthifolia (Schumach.) W. F. Wight. 1619, 1789.
Acacia ataxacantha DC. 1281.
A. brevispica Harms. (*A. pennata* Willd. partly). 2811. Mr. J. H. Ross of the Botany Department, University of Natal, Pietermaritzburg, after a quantitative taxonomic study, concludes as follows in a note to the author: "*A. brevispica* Harms and *A. schweinfurthii* Brenan and Exell are not distinct at specific level in Natal. The plants should consequently be referred to the older name, *A. brevispica*. Two infraspecific categories are recognized for specimens from the Tugela Basin, but their exact status is at present uncertain."
See also *A. schweinfurthii* below.
A. burkei Benth. 1552, 1797, 3040, 3042, 3044, 3056.
A. caffra (Thunb.) Willd. 706, 756, 896, 1927, 2834.
A. davyi N.E. Br. 2835, 2838.
A. gerrardii Benth. 1422.
A. karroo Hayne. 2836.
A. kraussiana Meisn.
A. mearnsii De Wild. (*A. mollissima* Auct. non Willd.) Introduced.
A. nilotica (L.) Del. ssp. *kraussiana* (Benth.) Brenan. 1429. (*A. arabica* (Lam.) Willd. var. *kraussiana* Benth.)

Photo. 120. Subalpine Fynbos of *Protea dracomontana*, *Widdringtonia dracomontana*, *Erica spp.* and many other species, on steep, rocky slopes relatively protected from fire. Below Mahlabachaneng Pass, Cathkin Peak area. c. 6,500 ft. 14/7/56.

Photo. 121. Alpine *Erica sp.* (=DE 360) Fynbos, showing dwarf shrub growth form and frost eroding bare patches. Mont aux Sources area. c. 10,000 ft. 18/11/54.

Photo. 122. Showing part of great basalt cliffs of escarpment, some 3,000 ft. high, and upper part of Tugela Falls. Fynbos on broken, sloping rock areas; tussocks of *Danthonia stereophylla* in cracks of sheer cliff at left; and Alpine Fynbos on flat summit area. 18/11/54.

Photo. 123. Mont aux Sources, and source of Tugela River. +10,000 ft. Showing undulating summit area of Alpine Belt; *Danthonia-Festuca-Pentaschistis* Grassland, with scattered patches of Alpine Fynbos, especially on rock outcrops, on stony shallow soils and on marshy areas near Tugela River. 18/11/54.

A. robusta Burch. 748, 887. From a detailed quantitative study of field populations, Dr. K. D. Gordon-Gray of the Botany Department, University of Natal, Pietermaritzburg, has concluded that *A. robusta* in the Tugela Valley cannot be distinguished from what has been referred to as *A. clavigera* E. Mey. along the coast. The older name, *A. robusta* Burch., has thus been retained in this account for coast as well as inland specimens.

(*A. schweinfurthii* Brenan & Exell.) (*A. pennata* Willd. partly) see *A. brevispica* above. 730, 763, 911, 1809, 3045, 959.

A. senegal (L.) Willd. var. *rostrata* Brenan. 1407, 1411, 1428.

A. sieberiana DC. var. *woodii* (Burtt Davy) Keay & Brenan. (*A. woodii* Burtt Davy). 1291.

A. tortilis (Forsk.) Hayne ssp. *heteracantha* (Burch.) Brenan. (*A. heteracantha* Burch.). 1427.

Dichrostachys cinerea (L.) Wight & Arn. ssp. *cinerea*. (*D. glomerata* (Forsk.) Chiov.). 789.

D. cinerea (L.) Wight & Arn. ssp. *nyassana* (Taub.) Brenan. (*D. nyassana* Taub.). 3032.

Elephantorrhiza elephantina (Burch.) Skeels. 1095.

Entada spicata (E.Mey.) Druce. 1564, 1620, 2332, 2730.

E. wahlbergii Harv. 1630, 1659.

Schotia brachypetala Sond.

Cassia laevigata Willd. 1712.

C. mimosoides L. 1597.

C. obovata Collad. 1208.

C. occidentalis L. 2793.

Hoffmannseggia sandersonii (Harv.) Benth. & Hook. 2818.

Caesalpinia decapetala (Roth.) Alston (*C. sepiaria* Roxb.) 1282. Introduced.

Calpurnia intrusa E. Mey. 490.

C. subdecandra (L'Herit.) Schweickerdt. 725, 804?, 934, 1014, 1121, 2316, 2374.

C. woodii Schinz. 2694.

Baphia racemosa Hochst. 1895.

Lotononis galpinii Dummer. 1151.

L. solitudinis Dummer. 1040.

L. trisegmentata Phillips. 2024.

L. wyliei Wood. 1478.

Buchenroedera lotononoides Scott Elliot. 536, 571, 1187.

B. viminea Presl. 2367.

Melolobium obcordatum Harv. 2026.

Crotalaria capensis Jacq. 1928.

C. globifera E. Mey. 3066.

C. monteroi Taub. ex Bak.f. var. *galpinii* Burtt Davy. 1245, 2741, 3061.

C. natalensis Bak.f. 1691.

Argyrolobium speciosum E. & Z. 1087.

A. tomentosum (And.) Druce. 2780, 3050.

Ulex europaeus L. 2112, 2681. Introduced.

Sarothamnus scoparius (L.) Wimmer. (*Cystisus scoparius* L.) 2457, 2671, 2680. Introduced.

Trifolium africanum Ser. var. *glabellum* (E. Mey.) Harv. 2678.

Indigofera cuneifolia E. & Z.967.

I. hedyantha E. & Z. 557.

I. hilaris E. & Z. 1094.

I. micrantha E. Mey. 1922.

I. natalensis Bolus. 2330, 2822.

Psoralea caffra E. & Z. 848, 966.

P. pinnata L. 1328, 1467.

P. polysticta Benth. 981.

Millettia grandis (E. Mey.) Skeels. (*M. caffra* Meisn.) 1341, 1362, 2470.

Lessertia thodei L. Bolus. 1183.

Aeschynomene micrantha DC. 1595.

Zornia capensis Pers. 1675.

Desmodium repandum (Vahl) DC. 1312.

Dalbergia armata E. Mey. 1525.

D. obovata E. Mey. 781.

Abrus precatorius L. 1660.

Erythrina humeana Spreng. 765.

E. latissima E. Mey.

E. lysistemon Hutch.

E. zeyheri Harv. 1026.

Rhynchosia caribaea DC. 674, 1814.

Eriosema cordatum E. Mey. 2220.

E. kraussianum Meisn. 1083.

Vigna longiloba Burtt Davy. 2786

Dolichos biflorus L. 3049.

D. schlechteri Harms. 2748.

Geraniaceae

Geranium ornithopodum E. & Z. 2285.

G. sp. cf. *G. canescens* L'Hér. 1131.

Monsonia attenuata Harv. 1172.

Pelargonium aconitiphyllum E. & Z. 2186.

Erythroxylaceae

Erythroxylum emarginatum Thonn. 1516.

E. pictum E. Mey. 817, 1337, 1348, 1458, 1576.

Rutaceae

Fagara capensis Thunb. 1008, 1065.

F. davyi Verdoorn. 1123.

Calodendrum capense Thunb. 320, 698.

Vepris reflexa Verdoorn. 917, 2503, 2770.

V. undulata Verdoorn. (*V. lanceolata* G. Don.). 758, 2502.
Teclea natalensis Engl. 284, 1751.
Clausena anisata (Willd.) Hook.f. 338, 776, 1611

BURSERACEAE

Commiphora caryaefolia Oliv. 1518, 1923.
C. harveyi Engl. 1521, 1545, 2467, 2772.
C. neglecta Verdoorn. 1256, 1408, 1709, 2083, 2465, 2788.

MELIACEAE

Ptaeroxylon obliquum Radlk. 269, 767.
Turraea floribunda Hochst. 1625, 1645, 1744.
T. obtusifolia Hochst. 1492, 1495.
Melia azedarach L. 877. Introduced.
Ekebergia capensis Sparrm. 481, 1078, 1285, 1339, 1531, 2643, 2668.
E. pterophylla (C. DC.) Hofmeyr. 2204.
Trichilia emetica Vahl. 1356, 1413, 1445. According to the recent article by White (Flora Zambesiaca, vol. 2. 1963), the epithet *T. roka* (Forsk.) Vahl has been incorrectly applied and two species are now recognized: *T. emetica* Vahl and *T. dregeana* Sond. It has, however, not been confirmed whether one or both these species occur in the Tugela Basin. If both species are found, then the tree in Coast Lowlands Forest and/or Semi-Coast Forest should be *T. dregeana* (see White), and that in drier areas and outside forest should be *T. emetica*.

MALPIGHIACEAE

Sphedamnocarpus galphimiifolius (Juss.) Szyszyl. 3036.
S. pruriens Planch. 1898.
Acridocarpus natalitius Juss. 1617.

POLYGALACEAE

Polygala hispida Burch. 345, 1150, 2269.
P. ohlendorfiana E. & Z. 3038.
P. sphenoptera Fresen. 3012.
P. virgata Thunb. 965.
Muraltia flanaganii Bolus. 357.
M. saxicola Chod. 346, 2231.
M. sp. 510.

DICHAPETALACEAE

Dichapetalum cymosum Engl.

EUPHORBIACEAE

Andrachne ovalis Mull. 523?, 553.
Drypetes arguta Hutch. 1644.
D. gerrardii Hutch. 1378, 1386, 1393, 2325.
Antidesma venosum Tul. 1694, 1697, 1873.
Bridelia micrantha Baill. 1541, 1574.
Croton gratissimus Burch. 2501.
C. menyhartii Pax. 2090.
C. sylvaticus Hochst. 1388, 1696, 1701.
Micrococca capensis Prain. 1530, 2110, 2329.
Erythrococca natalensis Prain. 1494, 2798.
Macaranga capensis Sim. 1700.
Acalypha glabrata Thunb. 1029.
A. punctata Meisn. 336, 411.
A. schinzii Pax.
A. wilmsii Pax. 1099.
Tragia sp. cf. *T. okanyua* Pax. 1666.
Dalechampia volubilis E. Mey. 1590.
Ricinus communis L. 2795. Introduced.
Jatropha natalensis Mull. Arg. 897.
Clutia abyssinica Jaub. & Spach. var. *abyssinica.* 1383. (*C. glabrescens* Knauf.).
C. affinis Sond. 2493.
C. galpinii Pax. 1462, 1924.
C. nana Prain. 362, 1993.
C. pulchella L. 821.
Suregada africana (Sond.) O.Ktze 2775.
Spirostachys africana Sond. 722, 1670.
Excoecaria sinii (O. Ktze) Pax. 835.
Sapium ellipticum (Hochst.) Pax. (*S. mannianum* Benth.)
S. integerrimum (Hochst. ex Krauss) J. Leonard (*S. reticulatum* Pax.) 1872, 3023.
Euphorbia clavarioides Boiss. 2162.
E. epicyparissias E. Mey. 929, 964.
E. evansii Pax. 900.
E. grandicornis Goeb. 1430, 1431.
E. ingens E. Mey.
E. pseudocactus Berger. 899, 2787.
E. rhombifolia Boiss. 904, 2509, 2760.
E. tirucalli L.
E. triangularis Desf. 2808, 2853.
E. sp. 2166.
Monadenium lugardae N.E. Br. 1799.

ANACARDIACEAE

Sclerocarya birrea (A. Rich.) Hochst. (*S. caffra* Sond.) 888, 960.
Protorhus longifolia Engl. 816, 2666.
Smodingium argutum E. Mey. 1310, 1471.
Heeria paniculosa (Sond.) O. Ktze. 766, 883, 890, 1311.
Rhus cordata E. Mey. ex A. DC. 867.
R. dentata Thunb. 705, 760.
R. dentata var. *grandifolia* Schonl. 374, 394, 963, 1277.
R. dentata var. *parviflora* (Harv.) Schonl.
R. discolor E. Mey. 556, 665, 969.
R. fastigiata E. & Z. 2246.
R. gerrardii Harv. 2046.

R. incisa L.f.
R. legatii Schonl. 782, 905, 907.
R. lucida L. 1076, 2523 (var.).
R. natalensis Bernh.
R. pentheri Zahlbr. 676, 724, 735, 1787, 1930, 2063.
R. pyroides Burch. 1056, 1223.
R. rehmanniana Engl. 677, 687, 704, 1270.
R. simii Schonl. 1581, 1874.
R. tomentosa L. 373, 533, 891.
R. sp. 461.
Mangifera sp. 1560. Introduced.

AQUIFOLIACEAE

Ilex mitis (L.) Radlk. 300, 399, 401, 472.

CELASTRACEAE

Maytenus acuminatus (L.f.) Loes. (*Gymnosporia acuminata* Szyszyl.) 521, 813, 1340.

M. cymosus (Soland.) Exell. (*Gymnosporia buxifolia* Szyszyl.). The systematic position of this 'species' is far from clear. Difficulty arises when considering herbarium material which does not show obvious differences that may readily be apparent in the field. Leaf shape in particular is most variable, though it is generally broadest on primary leaves and narrowest on the secondary leaves borne on dwarf shoots. Characters which appear significant are growth form, bark, fruits, distribution and ecological behaviour. The following notes are given since they may be of some value to taxonomists, and also because it has been found necessary in the text of this report to distinguish taxonomic categories. These taxa are given here as 'forms': they may be of specific or lower rank. Except for the moist climatic form (DE 970), all the forms may be found growing in proximity to each other in the Muden area of the lower Mooi River valley.

M. cymosus typical form (*DE 1491*). 744, 755, 1017, 1273, 1481, 1491. This is a small tree, from 4 to 15 ft high, branching from one to four feet above ground level. The bark is thick, fissured, corky and black on the main stem, light grey on the twigs. Leaves are relatively thick and glaucous. Capsules are pink. The form occurs chiefly in the moister marginal areas of the Valley Region, in the Interior Basins Region and in the Coast Lowlands Region.

M. cymosus forma *DE 1253*. 731, 732, 1201, 1253, 2087, 2511, 2756. A definite shrub, up to 10 ft high, branching at ground level. The bark is thin, light brown to light grey, and the leaves are green and relatively thin. Capsules are pink and similar to those of the typical form. Forma DE 1253 occurs only in dry areas of the Valley Region, where it may form secondary thickets on old lands.

M. cymosus forma *DE 958*. 777, 912, 958, 1218, 2812. A definite shrub, with a relatively thin, light brown to grey bark. Similar to forma DE 1253, but larger, up to 15 ft high, more bushy, with larger, thinner, dark green leaves and longer, more robust spines. The chief character differentiating it from forma DE 1253, however, is the very numerous, light brown, round capsules packed tightly along the shoots. The form occurs in dry areas of the Valley Region on alluvial soils, usually fairly close to water or locally moister conditions.

M. cymosus forma *DE 2507*. 2507, 2784, 2810. A definite shrub, similar in distribution, in size and in leaf characters to forma DE 1253. The form is less common, however, and the bark on the twigs is a dark grey. Capsules are yellow to orange coloured, rounder, and slightly more fleshy than in forma DE 1253.

M. cymosus moist climatic form (*DE 970*). 302, 970, 1103. This is similar to the typical form (DE 1491) in general growth, but occurs in moist regions, where it may be found on forest margins, as for example, in the Royal Natal National Park. The bark is not conspicuously thick and the leaves are thin and green in colour, as compared with the typical form. Fruits have not been noted.

M. mossambicensis (Klotzsch) Blakelock. (*Gymnosporia harveyana* Loes.). 832, 1062, 1106, 1309.

M. nemorosus (E. & Z.) Marais. (*Gymnosporia nemorosa* Szyszyl.). 1275, 1776, 1794.

M. peduncularis (Sond.) Loes. (*Gymnosporia peduncularis* (Loes.). 247, 251, 303, 398, 1069.

M. senegalensis (Lamb) Exell. (*Gymnosporia senegalensis* Loes.). 299, 875.

M. undatus (Thunb.) Blakelock. (*Gymnosporia undata* Szyszyl.; and others). 316, 317, 460, 738, 931, 1054?, 1070, 1115, 1503, 1654, 1796, 2774.

M. sp. (cf. *Pentz 216*). 2506, 2759, 2761, 2800. This has been referred to *M. cymosus* but is apparently distinct because of the large woody fruits over 0·5 ins in diameter. It is a rather spindly, though rigidly spinescent shrub, up to 10 ft high, similar in leaf and bark characters to *M. cymosus* forma *DE 1491*.

M. sp. (cf. Pentz 216) occurs in dry areas of the Valley Region, but is found only occasionally.

M. sp. 1562, 2842.

Putterlickia verrucosa Szysz. 1351.

Catha edulis Forsk. 2250.
Pterocelastrus galpinii Loes. 2634.
P. sp. 318, 319, 463, 471, 473, 500, 560.
Cassine aethiopica Thunb. 1280, 2253.
C. euclaeformis O. Ktze. 2652.
C. kraussiana Bernh. 2649.
C. laurifolium (Harv.) Davison. 1807.
C. papillosa O. Ktze. 809, 1114?, 1506, 2093, 2308, 2310, 2832.
C. sphaerophylea O. Ktze. 1803.
C. tetragona (Thunb.) Loes. var. *laxa.* 689?, 2839.
C. sp. 1456, 1498.
Pseudocassine transvaalensis (Burtt Davy) Bredell. 762, 884, 885, 894, 902, 936, 1840, 2466.
Pleurostylia capensis Turez Oliv. 501, 2529.

ICACINACEAE

Cassinopsis ilicifolia O. Ktze. 468, 495, 678.
C. tinifolia Harv. 1336, 1442.
Apodytes dimidiata E. Mey. 1071?, 1346, 1443, 1548, 1583, 1738, 1790, 1793, 1804, 2653.
Pyrenacantha scandens Planch. ex Harv. 3047.

SAPINDACEAE

Allophylus dregeanus (Sond.) de Winter. (*A. monophyllus* Radlk.). 1314, 2098.
A. erosus Radlk. 277, 1754.
A. melanocarpus Radlk. (*A. africanus* DC.). 499, 1061, 1278, 1861.
Deinbollia oblongifolia Radlk. 1745, 1850.
Pappea capensis E. & Z. 740.
Hippobromus pauciflorus (L.f.) Radlk. 246, 502, 757, 930.

MELIANTHACEAE

Bersama tysoniana Oliv. 1315, 1380, 1387, 2661.
Greyia sutherlandii Hook. & Harv.

BALSAMINACEAE

Impatiens duthieae L. Bolus. 1306.

RHAMNACEAE

Scutia myrtina (Burm.f.) Kurz.
Rhamnus prinoides L'Hérit. 547, 771, 2690.
Phyllogeiton zeyheri (Sond.) Suesseng. (*Rhamnus zeyheri* Sond.) 726, 1030.
Phylica paniculata Willd. 2240, 2656.
P. thodei Phillips. 2147.
Helinus integrifolius (Lam.) O. Ktze. 1929, 2640.

HETEROPYXIDACEAE

Heteropyxis natalensis Harv. 819, 1283, 1347, 1475.

VITACEAE

(*Rhoicissus capensis* Planch.). *R. tomentosa* (Lam.) Wild & Drummond. 1618.
R. digitata (L.f.) Gilg & Brandt. 1724.
R. revoilii Planch. 538, 2020.
R. rhomboidea (E. Mey. ex Harv.) Planch. 690, 1375, 1766, 1760.
R. tridentata (L.f.) Wild & Drummond. (*R. cuneifolius* (E. & Z.) Planch.). 410, 493, 750, 1007, 1224, 1571, 1669.
Cyphostemma cirrhosum (Thunb.) Descoings ssp. *transvaalense* (Szyszyl.) Wild & Drummond. (*Cissus cirrhosa* var. *transvaalensis* (Szyszyl.) Burtt Davy). 1569, 1594, 1749?, 2091.
C. congestum (Bak.) Desc.
C. lanigerum (Harv.) Desc. (*Cissus lanigera* Harv.).
C. sandersonii Harv. (*Cissus sandersonii* Harv.). 1202.
C. sp. 1033, 1060, 1770, 1609.
Cissus fragilis E. Mey. 1750, 1752, 1860.
C. quadrangularis L. 1540, 2731.

TILIACEAE

Corchorus junodii (Schinz) N.E. Br. 1638, 1673, 3024.
Grewia flava DC. 1215.
G. monticola Sond. 1216, 1409, 1420.
G. occidentalis L. 746, 793, 1005, 1517, 1559, 1601.
G. sp. 1025.

MALVACEAE

Abutilon austroafricanum Hochr. 2086, 2089.
A. galpinii A. Meeuse. 1688.
Hibiscus calyphyllus Cav. 1689, 1811, 2782.
H. micrantlus L.f. 2773.
H. pusillus Thunb. 1596.

STERCULIACEAE

Dombeya cymosa Harv. 268, 699, 1015, 1222, 2757.
D. pulchra N.E. Br. 1057.
D. rotundifolia Harv. 286, 841.
Hermannia sp. cf. *H. gerrardii* Harv. 2025.
Waltheria indica L. 1360.

OCHNACEAE

Ochna arborea Burch. 2311, 2655?
O. atropurpurea DC. 240?, 2693.
O. holstii Phillips. 2667.
O. natalitia (Meisn.) Engl. 1523, 2663.
O. o'connori Phillips. 2650.
O. sp. 1111, 1371.

GUTTIFERAE

Hypericum revolutum Vahl. 1403.
H. sonderi Bredell. 1088.
(*Garcinia gerrardii* Harv.). *G. natalensis* Schltr. 2660.

VIOLACEAE

(*Rinorea natalensis* Engl.). *Rinorea angustifolia* (Thou.) Baill. 1107, 1109, 1526.

FLACOURTIACEAE

Rawsonia lucida Harv. & Sond. 833, 1389, 2323, 2328.
Xylotheca kraussiana Hochst. var. *kraussiana* (*X. kotzei* Phillips). 1636, 1708, 1791.
Kiggelaria africana L. 470, 475, 1020, 1079, 1290.
Scolopia mundtii (E. & Z.) Warb. 371, 480, 485, 491, 548, 550, 1021, 1441.
S. zeyheri (Nees) Harv. (includes *S. ecklonii* (Nees apud E. & Z.) Harv.) 918, 961, 1608, 2326?, 2482.
S. sp. aff. *S. flanaganii* Sim. 2164.
Homalium dentatum (Harv.) Warb. 1366, 1368, 2639, 2648.
Trimeria grandifolia (Hochst.) Warb. 323, 546, 1276, 1584, 1591, 1612.
Dovyalis caffra (Hook.f. & Harv.) Warb. 913.
D. lucida Sim. 691, 695, 1505?, 2633, 2646.
D. rhamnoides Harv. 1582.
D. zeyheri (Sond.) Warb. (*D. tristis* (Sond.) Sim). 988, 2371, 2451.
Casearia junodii Schinz. 1446.

ACHARIACEAE

Ceratiosicyos laevis (Thunb.) Meeuse. 2101, 2105.

BEGONIACEAE

Begonia sutherlandii Hook.f. 465, 2688.

CACTACEAE

Rhipsalis baccifera (J. Mill.) Stearn. (*R. cassytha* Gaertn.). 1795.

OLINIACEAE

Olinia emarginata Burtt Davy. 464, 478?, 492.
O. radiata Hoffm. & Phill. 1369, 1379.

THYMELAEACEAE

Peddiea africana Harv. 1122, 1501, 1761, 1767, 2106.
Gnidia fastigiata Rendl. 344.
Arthrosolen calocephalus C. A. Mey. 2209, 2481.
Lasiosiphon anthylloides Meisn. 2131.
L. burchellii Meisn. 1497, 2468.
L. caffer Meisn. 1092.
L. capitatus (L.f.) Burtt Davy. 3041.
L. kraussianus Meisn. 384.
L. splendens Endl. 1786, 2479.
Basutica aberrans (C. H. Wr.) Phillips. 363, 1137.
Englerodaphne pilosa Burtt Davy ex descr. 2247.
Passerina filiformis L. 820.
P. montana Thoday. 1991, 2239, 2276.
P. sp. 973, 974.
Dais cotinifolia L. 775, 995, 1031, 1058.

LYTHRACEAE

Rotala sp. 3121.

LECYTHIDACEAE

Barringtonia racemosa (L.) Roxb. 2532.

RHIZOPHORACEAE

Cassipourea gerrardii Alston. 1392, 1444.
C. gummiflua Tul. var. *verticillata* (N. E. Br.) J. Lewis. 1370, 1435.

COMBRETACEAE

Combretum apiculatum Sond. 716, 796, 802, 807, 1410, 2213, 2747, 2749.
C. erythrophyllum (Burch.) Sond. 770, 879.
C. gueinzii Sond. 822, 1284, 1287, 1294, 1469, 1635, 1706, 1832, 1833, 2214, 2215.
C. kraussii Hochst. 2108, 2217, 2651.
C. woodii Dummer. 1710, 1719, 1827, 1835, 2082, 2746.

MYRTACEAE

Psidium guajava L. 1352. Introduced.
Eugenia capensis Harv. 292, 1735, 1737.
E. natalitia Sond. 1395, 3026.
E. zeyheri Harv. 1504?
E. sp. near *E. natalitia* Sond. 1349, 1544, 1588, 1589, 1863, 1921.
E. sp. cf. *E. zuluensis* Dum. 2241.
Syzygium cordatum Hochst.
S. gerrardii Harv. 1119, 1460, 1528, 2665.
S. guineense (Willd.) DC. 1028, 1419, 2073.
S. sp. 880.

MELASTOMATACEAE

Dissotis canescens (E. Mey. ex Graham) Hook.f. 3065.

ONAGRACEAE

Ludwigia adscendens (L.) Hara ssp. *diffusa* (Forsk.) Raven. (*Jussieua repens* L.). 3133.
Oenothera rosea Ait. 428.

HALORRHAGIDACEAE

Gunnera perpensa L. 2199, 2356.

ARALIACEAE

Cussonia kraussii Hochst. 1342, 1626, 1813.
C. natalensis Sond. 1421, 2804.
C. paniculata E. & Z. 257, 259.
C. spicata Thunb.
C. umbellifera Sond. 1448.
Seemannaralia gerrardii (Seem.) Viguier. 1110.

UMBELLIFERAE

Heteromorpha trifoliata (Wendl.) E. & Z. 2499
Bupleurum mundtii Cham. & Schlecht. 1178.
Sium repandum Welw. ex Hiern. 2399.
Peucedanum caffrum Phillips. 424.

CORNACEAE

Curtisia dentata (Burm.f.) C. A. Sm. 1450

ERICACEAE

Erica aestiva Mark. 2454.
E. algida Bolus. 1994, 2142, 2270, 2274, 2293.
E. alopecurus Harv. 2009.
E. alticola Guthrie & Bolus. 2001 var.?
E. caffrorum Bolus. 372, 405, 514, 977, 2116, 2230, 2232, 2820.
E. cerinthoides L. 972.
E. cubica L. 1486.
E. ebracteata Bolus. 1989, 2126, 2152.
E. frigida Bolus. 1140, 2141, 2289, 2295.
E. leucopelta Tausch. 1401.
E. natalitia Bolus. 1464.
E. oatesii Rolfe. 1997.
E. thodei Guthrie & Bolus. 614, 1141, 2016, 2137.
E. westii L. Bolus. 1995, 2000, 2275.
E. woodii Bolus. 1332, 1998, 2273.
E. sp. 360, 1990, 1996, 2002, 2134, 2455.
Philippia evansii N. E. Br. 1988, 2163.

MYRSINACEAE

Maesa alnifolia Harv. 1534.
M. lanceolata Forsk. (*M. rufescens* A. DC.). 1120, 1269.
Embelia ruminata (E. Mey. ex Drege) Mez. 1773.
Myrsine africana L. 256, 392, 971.
M. pillansii Adamson. 2461.
Rapanea melanophloeos (L.) Mez. 250, 301, 321, 1440.

SAPOTACEAE

Sideroxylon inerme L. 935, 1632, 1705, 1753.
Bequaertiodendron natalense (Sond.) Heine & Hemsley. 1390, 1778. (*Chrysophyllum natalense* Sond.)
Mimusops obovata Sond. 878, 1345, 1423, 1424, 1567, 1616, 1864, 2072, 2317, 2841.
Austromimusops dispar (N. E. Br.) A. Meeuse. (*Mimusops dispar* N. E. Br.). 881, 916, 2077, 2080, 2252, 2464, 2799.
Manilkara concolor (Harv.) Gerstner. (*Mimusops concolor* Harv. ex. C. H. Wr.). 1868.

EBENACEAE

Diospyros austro-africana de Winter var. *rubriflora*. (*Royena hirsuta* var. *rubriflora* de Winter). 395, 2007, 2173, 2338.
D. dichrophylla (Gand.) de Winter. (*Royena pubescens Willd.*). 1359, 1587, 1686, 1777.
D. glandulifera de Winter. (*Royena glandulosa* Harv.). 810, 1652, 1897, 2744.
D. lycioides Desf. ssp. *guerkei* (O. Ktze.) de Winter. (*Royena guerkei* O. Ktze. ex Hiern). 664, 671, 842, 1010, 1016, 1019, 1271, 1539, 1563, 2358, 2360. This subspecies occurs chiefly from the Biggarsberg northwards, where it frequently forms scrub communities. The following subspecies occurs south of the Biggarsberg, only occasionally forming communities in the Tugela Basin area.
D. lycioides Desf. ssp. *sericea* (Bernh.) de Winter. (*Royena sericea* Bernh.). 688, 752, 768, 937, 938, 1204, 1206, 2256, 2263, 2266, 2340, 2359, 2755.
D. natalensis (Harv. ex Hiern) Brenan. (*Maba natalensis* Harv.) 1764, 1805.
D. scabrida (Harv. ex Hiern) de Winter. 1343, 1585.
D. simii (O. Ktze.) de Winter. (*Royena simii* Kuntze). 1279, 1451, 1543, 1653, 1858.
D. villosa (L.) de Winter var. *villosa*. (*Royena villosa* L.) 1363, 1365, 1780.
D. whyteana (Hiern) F. White. (*Royena lucida* L.). 252, 258, 407, 978, 979, 1473, 2182.
Euclea crispa (Thunb.) Sond. ex Guerke var. *crispa*. (*Euclea lanceolata* E. Mey. ex A. DC.). 241, 249, 406, 408, 552, 749, 892, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 1032, 1055, 1580, 1605.
E. natalensis A. DC. (*E. multiflora* Hiern). 283, 1622, 1886.
E. schimperi (A. DC.) Dandy var. *daphnoides* (Hiern) de Winter. (*E. daphoindes* Hiern). 739, 903, 952, 1841, 1885, 2088.

OLEACEAE

Schrebera alata (Hochst.) Welw. 1524, 1715, 1783.
S. argyrotricha Gilg. 1405.
Olea africana Mill. 723, 1707.
O. capensis L. ssp. *enervis* (Harv.) Verd. (*O. enervis* Harv. ex. C. H. Wr.). 1788.
O. capensis L. ssp. *macrocarpa* (C. H. Wr.) Verdoorn. (*O. macrocarpa* C. H. Wr.). 1376, 1384, 1508?
Linociera foveolata (E. Mey.) Knobl. ssp. *foveolata* (*Olea foveolata* E. Mey.). 2251, 2443, 2692.
L. peglerae (C. H. Wr.) Gilg & Schellenb. (*Olea peglerae* C. H. Wr.). 1113, 2645.
Jasminum breviflorum Harv. 1692, 2341.
J. multipartitum Hochst. 1575.
J. stenolobum Rolfe. 1651.
J. sp. 792.

SALVADORACEAE

Azima tetracantha Lam. 1713.

LOGANIACEAE

Strychnos decussata (Pappe) Gilg. (*S. atherstonei* Harv.). 2076, 3009.
S. henningsii Gilg. 1385?, 2657.
S. innocua Del. ssp. *dysophylla* Benth. (*S. dysophylla* Benth.)

S. innocua Del. ssp. *gerrardii* (N. E. Br.) Verdoorn. (*S. gerrardii* N. E. Br.). 2831.

The *S. innocua* complex proves difficult in the Tugela Basin. In the Coast Lowlands Region specimens are staisfactorily referred to *S. innocua* ssp. *gerrardii*, and in the Maqumbi area of the lower Tugela Valley most plants can be regarded as *S. innocua* ssp. *dysophylla*. Further inland, however, at Middledrift below Kranskop trees display a mixture of the characters of the two subspecies and are thus best referred to simply as *S. innocua*.

S. spinosa Lam. 1406, 1549, 1550.

S. usambarensis Gilg. (*S. micans* S. Moore). 290.

Nuxia congesta R. Br. ex Fres. (*Lachnopylis congesta* C. A. Smith). 1338, 1374, 1459, 1515.

N. floribunda Benth. (*Lachnopylis floribunda* (Benth.) C. A. Sm.). 1116, 1117, 1466.

N. oppositifolia (Hochst.) Benth. (*Lachnopylis oppositifolia* Hochst.). 1613, 2056.

Buddleia auriculata Benth. 1001, 1059, 1489.

B. corrugata (Benth.) Phillips.

B. pulchella N. E. Br. 1404, 1433.

B. saligna Willd. (*B. salicifolia* Jacq.) (*Chilianthus arboreus* A. DC.). 1499, 1570.

B. salviifolia (L.) Lam.

(*Chilianthus dysophyllus* Benth.). *Buddleia dysophylla* (Benth.) Radlk. 1004.

Gentianaceae

Sebaea procumbens A. W. Hill. 1160.

S. sedoides Gilg. 2003.

S. spathulata Steud. & Griseb. 351.

Chironia baccifera L. 1736.

C. krebsii Griseb. 2203, 2426, 2431.

Apocynaceae

Acokanthera oblongifolia (Hochst.) L. E. Codd. (*A. spectabilis* (Sond.) Hook.f.). 1775.

A. oppositifolia (Lam.) L. E. Codd. (*A. venenata* sensu Stapf in Fl. Trop. Afr. and Fl. Cap.). 788, 1627, 1698, 2528.

Carissa bispinosa (L.) Desf.

C. macrocarpa (Eckl.) A. DC. (*C. grandiflora* (E. Mey.) A. DC.) 1568, 1740.

Tabernaemontana elegans Stapf (*Conopharyngia elegans* (Stapf) Stapf).

T. ventricosa Hochst. ex A. DC. (*Conopharyngia ventricosa* ex A. DC.) Stapf.

Voacanga thouarsii R. & S. (*V. dregei* E. Mey.).

Rauvolfia caffra Sond. (*R. natalensis* Sond.).

Strophantlus gerrardii Stapf. 1834.

S. speciosus Reber. 1436, 2315.

Wrightia natalensis Stapf. 1875.

Asclepiadaceae

Tacazzea apiculata Oliv. 2833.

Raphionacme flanaganii Schltr. 1810, 2771.

Xysmalobium gerrardii Scott Elliot. 1086.

Schizoglossum hornatum E Mey 1179.

Pentarrhinum insipidum E. Mey. 2745.

Cynanchum tetrapterum (Turcz.) R. A. Dyer. 1916, 3048.

Sarcostemma viminale R. Br. 787?, 1658, 1699, 1931.

Secamone alpinii Schultes. 276?, 489, 545?, 1527, 1746.

S. gerrardii Harv. 2318.

S. parviflora (Oliv.) Bullock. 484?

Ceropegia linearis E. Mey. 3017, 3028.

C. pachystelma Schltr. 1894?, 3018, 3019, 3020.

C. plicata E. A. Bruce. 1801.

C. sandersonii Decne ex Hook.f. 1800, 3043.

C. setifera Schltr. var. *natalensis* N. E. Br. 1802, 3007, 3021.

C. sp. 1893, 1896.

Riocreuxia torulosa Decne. 2216.

Duvalia polita N. E. Br. 2763.

Stapelia gigantea N. E. Br. 1848.

Huernia hystrix N. E. Br. 2732.

Gymnema sylvestre R. Br. 1358, 1915, 3008.

Tylophora flanaganii Schltr. 2635.

Marsdenia dregei (Harv.) Schltr. 2781.

Pergularia daemia (Forsk.) Blatter. 1648.

Convolvulaceae

Merremia pterygocaulos (Choisy) Hall.f. 3037.

M. tridentata (L.) Hall.f. ssp. *angustifolia* (Jacq.) Ooststr. 1674.

Ipomoea albivenia (Lindl.) Sweet. 895.

I. pes-caprae L. 1729.

I. senensis (Desr.) Choisy ssp. *blepharosepala* Hochst. ex A. Rich. 2789.

Boraginaceae

Cordia caffra Sond. 1604, 1743, 1913.

Ehretia rigida (Thunb.) Druce. 803, 910, 985, 1267.

Tysonia africana Bolus. 541.

Myosotis afropalustris C. H. Wr. 1155.

Verbenaceae

Verbena bonariensis L. 2047.

Lantana rugosa Thunb. (*L. salvifolia* Jacq.). 1661, 2790.

Lippia javanica (Burm.f.) Spreng. (*L. asperifolia* Rich.). 790, 1265, 1533.

Chascanum hederaceum (Sond.) Moldenke. 2778.

C. latifolium (Harv.) Moldenke. 1018.

Priva cordifolia (L.f.) Druce. 3013.

Premna mooiensis (Pearson) Pieper. (*Vitex mooiensis* H. H. W. Pearson). 737, 893, 906, 933, 2792.
Vitex harveyana H. H. W. Pearson. 1643, 1646.
V. rehmannii Guerke. 700, 759, 838?, 1554, 2218.
V. sp. 798.
Clerodendrum glabrum H. H. W. Pearson. 795, 1452, 1553, 1828, 2644.
C. triphyllum (Harv.) H. H. W. Pearson. 1089.
C. sp. 670, 751, 1075.

LABIATAE

Teucrium riparium Hochst. 1266.
Leonotis dysophylla Benth.
L. leonurus R. Br.
Leucas glabrata R. Br. 1822.
Lasiocorys capensis Benth. 1244.
Endostemon obtusifolius N. E. Br. 1825.
Plectranthus calycinus Benth. 540.
P. cylindraceus Hochst. ex Benth. 2067, 2749.
P. dolichopodus Briq. 2097.
P. ecklonii Benth.
P. fruticosus L'Hérit. 1816, 2102, 2682.
P. grallatus Briq. 543.
P. laxiflorus Benth. 2099, 2100.
P. madagascariensis (Pers.) Benth. 3010.
P. natalensis Guerke.
P. tomentosus Benth. 1396.
Iboza riparia N. E. Br. 1472, 1479.
Syncolostemon macrantlus (Guerke) Ashby. 2130.
S. rotundifolius DC. 1397.
Hemizygia pretoriae (Guerke) Ashby. 1084.
H. stenophylla (Guerke) Ashby. 459, 2300.
Ocimum americanum L. 2796.
O. urticifolium Roth. 1824.
Becium obovatum N. E. Br. 1085.
Nautochilus labiatus (N. E. Br.) Brem. 714, 1815.

SOLANACEAE

Lycium pendulinum Miers. 717?
L. sp. cf. *L. oxycladum* Miers. 1210.
L. sp. 2061.
Solanum giganteum Jacq. 1318.
S. incanum L. 1671.
S. mauritianum Scop. (*S. auriculatum* Ait.). Introduced.
S. panduraeforme E. Mey. 439.
Datura ferox L. 2797. Introduced.
Cestrum laevigatum Schlecht. 1829. Introduced.

SCROPHULARIACEAE

[illegible]ia purpurea N. E. Br. 1182.
[illegible] nov. 1166 (cf. Killick 1488, 1912).
[illegible]ceptans Benth. 2161.
Dermatobotrys saundersii Bolus. 1454.
Halleria lucida L.
Phygelius aequalis Harv. 2361.
Anastrabe integerrima E. Mey. 808, 818, 1118, 1305, 1329.
Bowkeria triphylla Harv. 324, 370.
B. verticillata (E. & Z.) Druce. 2636.
Manulea rhodeana Diels. 1192.
Sutera breviflora Hiern. 1176.
S. brunnea Hiern. 2069.
S. burkeana Hiern. 1474.
S. kraussiana Hiern. 2064.
S. sp. aff. *S. pristisepala* Hiern. 1157.
Zaluzianskya alpestris Diels. 1159.
Z. capensis Walp. 2027.
Z. maritima Walp. 1173, 1174.
Z. ovata Walp. 1164.
Z. sp. 1153.
Mimulus gracilis R. Br. 2424.
Limosella longiflora O. Ktze. 3122.
L. maior Diels. 2674, 2696.
L. sp. cf. *L. grandiflora* Benth. 2188, 2370.
Hebenstreitia dentata L. 569, 997?, 1152.
Selago flanaganii Rolfe. 2291.
S. longipedicellata Rolfe. 1463.
S. natalensis Rolfe. 1325, 1785.
Glunicalyx montanus Hiern. 1158.
Alectra bainesii Hemsl. 2779.
Buttonia natalensis McKen. 1870.
Graderia scabra Benth. 383, 1093, 2167.
Sopubia cana Harv. 572.
Cycnium adonense E. Mey. 1100, 2312.
C. racemosum Benth. 1170.
Striga elegans Benth. 435.
Harveya speciosa Bernh. 1603.

BIGNONIACEAE

Tecomaria capensis (Thunb.) Spach.
Kigelia pinnata DC. 2074, 2469.

PEDALIACEAE

Ceratotheca triloba E. Mey 1259.

GESNERIACEAE

Streptocarpus cooksonii Burtt. 2801.
S. cooperi C. B. Cl. 1307.
S. gardenii Hook. 2817.
S. pentherianus Fritsch. 2815.

ACANTHACEAE

Thunbergia dregeana Nees. 1769.
T. natalensis Hook. 1703.
Chaetacanthus setiger (Pers.) Lindl. 1823, 1852.

Ruellia patula Jacq. 2459.
Barleria argillicola Oberm. 2458.
B. elegans S. Moore. 1830, 1857, 3022.
B. lancifolia T. Anders. 2500.
B. monticola Oberm. 380, 2129.
B. obtusa Nees. 733, 1240, 1812, 2754.
Blepharis integrifolia (L.f.) E. Mey. 719, 1853, 3016.
B. maderaspatensis (L.f.) Heyne ex Roth. 1819, 1892, 3014.
B. natalensis Oberm. 797, 1211, 2758.
Crossandra fruticulosa Lindau. 3039.
C. greenstockii S. Moore. 1690.
Asystasia gangetica (L.) T. Anders. 1623, 3058.
Peristrophe natalensis T. And. 785.
Dicliptera heterostegia Presl. ex Nees. 2104.
Hypoestes aristata R. Br. 2095.
H. triflora Roem. & Schult. 2094.
H. verticillaris R. Br. 1242, 1438.
Mackaya bella Harv. 2314.
Duvernoia adhatodioides E. Mey. 1367.
Ruttya ovata Harv. 1859.
Justicia campylostemon Anders. 2480.
J. flava (Vahl) Vahl. 1655, 1851.
J. kraussii C. B. Cl. 1925, 3059.
J. odora Vahl. 2791.
Monechma debile (Forsk.) Nees. 1818.

Rubiaceae

Kohautia virgata (Willd.) Brem. var. *virgata*. (*Oldenlandia caffra* E. & Z.) 1681.
Cephalanthus natalensis Oliv. 890, 1023, 1080, 2118.
Tarenna barbetonensis (Brem.) Brem. 1782.
Burchellia bubalina (L.f.) Sims. 469, 479.
Gardenia cornuta Hemsl. 1631, 1849, 2071, 2078.
G. neuberia E. & Z. 814, 1274, 1455.
Rothmannia capensis Thunb. (*Gardenia rothmannia* L.f.). 2477, 2637.
R. globosa (Hochst.) Keay. (*Gardenia globosa* Hochst.). 1449, 1453, 1628, 1668.
Oxyanthus gerrardii Sond. 2647.
Tricalysia capensis (Meisn.) Sim. 1394, 1437, 2662.
T. lanceolata (Sond.) Burtt Davy. 1792.
T. sonderiana Hiern. 282.
Kraussia floribunda Harv. 1579, 1747.
Alberta magna E. Mey. 1334.
Pentanisia prunelloides (Klotzsch) O. Ktze. 378, 425.
Vangueria infausta Burch. 811, 1027.
Canthum ciliatum (Kl.) O. Ktze. 322, 409, 477, 968, 1022, 1862.
C. gilfillanii (N. E. Br.) O. B. Miller. 983, 984.
C. gueinzii Sond. 1308, 1381.
C. inerme (L.f.) O. Ktze. 1102, 1316, 1353, 1537, 1547.
C. locuples (K. Schum.) Codd. 1633, 1649, 1650, 1717, 1718, 1781.
C. mundtianum Cham. & Schlecht. 488, 794, 812, 1003, 1034, 1073, 1203, 2065.
C. obovatum Klotzsch. 2654, 2659.
C. pauciflora (Klotzsch.) O. Ktze. 482, 486, 497, 696.
Pachystigma macrocalyx (Sond.) Robyns. 666, 823, 1000, 1063, 1205, 1327, 1621?
P. sp. 496.
Pavetta assimilis Sond. 982, 1207, 2255.
P. cooperi Harv. & Sond. 404, 998, 1024, 1077, 2123, 2339.
P. gracilifolia Brem. 1887.
P. khomghensis Brem. 1546, 1629.
P. lanceolata Eckl. 281, 1354, 1426, 1538, 2683.
P. natalensis Sond. 1373.
P. revoluta Hochst. 1739.
P. tristis Brem. 1507, 2324.
P. sp. 675, 747, 831.
Grumilea capensis Sond. 1108, 1350, 1502, 1573.
Anthospermum hispidulum E. Mey. 1333.
A. sp. 2236.
Richardia braziliensis Gomez. 1679. Introduced.
Borreria scabra (Schumach. & Thonn.) K. Schum. 3063.
Galium sp. cf. *G. wittebergense* Sond. 1177.
Xeromphis obovata (Hochst.) Keay. 1647, 1667, 1798, 1867, 1869.
X. rudis (E. Mey. ex Harv.) Codd. (*Randia rudis* E. Mey. ex Harv.) 734, 1551.

Valerianaceae

Valeriana capensis Thunb. 2271.

Dipsacaceae

Cephalaria attenuata R. & Sch. 431.
Scabiosa columbaria L. 1156.

Cucurbitaceae

Melothria cordata (Thunb.) Cogn. 1808, 2373.
Kedrostis foetidissima Jacq. Cogn. ssp. *obtusiloba* (Sond.) A. Meeuse. 1856.
Cucumis metuliferus E. Mey. ex Schrad. 2084.
Coccinia palmata (Sond.) Cogn. 2107, 2372, 2375.
C. rehmannii Cogn. 3053.

Campanulaceae

Wahlenbergia montana A. DC. 2383.
Cyphia elata Harv. 1171.
Lobelia decipiens Sond. 1041, 2402, 2440.
L. preslii A. DC. 2816.

GOODENIACEAE

Scaevola thunbergii E. & Z. 1730.

COMPOSITAE

Vernonia cistifolium O. Hoffm. 2319.
V. gerrardii Harv. 426.
V. hirsuta Sch. Bip. 313, 1190, 2187.
V. mespilifolia Less. 1476.
V. natalensis Sch. Bip. 437.
V. oligicephala (DC.) Sch. Bip. ex Walp. 1663, 1677.
Aster bakerianus Burtt Davy ex C. A. Sm. 312, 382, 2313.
A. filifolius Vent. 753, 1246, 2150, 2155.
A. hyssopifolius Berg. 3055.
A. perfoliatus Oliv. 376.
Erigeron canadense L. 1672, 2028. Introduced.
Microglossa mespilifolia (Less.) Robinson. 1614, 1687.
Brachylaena elliptica (Thunb.) Less. 274, 761, 837?, 1493, 2066, 2783.
B. ilicifolia (Lam.) Phillips & Schweickerdt. 273, 2081.
B. transvaalensis Phillips & Schweickerdt. 1457, 1529, 2658.
Tarchonanthus camphoratus L. 703, 728, 1243, 2062, 2505.
T. trilobus DC. 1784.
Denekia capensis Thunb. 2425.
Helichrysum adenocarpum DC. 593, 1398.
H. aureonitens Sch. Bip. 375, 444.
H. bellidiastrum Moeser. 355, 1163.
H. chionosphaerum DC. 2117, 2121.
H. fulgidum (L.) Willd. var. *monocephalum* DC. 341.
H. grandibracteatum M. D. Henderson. 343.
H. infaustum Wood & Evans. 348.
H. latifolium Less. 365.
H. leptolepis DC. 3064.
H. marginatum DC. 612, 1161, 1162.
H. milfordiae Killick. 1154.
H. nanum Klatt. 1142.
H. nudifolium (L.) Less. var. *leiopodium* (DC.) Moeser. 429.
H. odoratissimum (L.) Less. 2156.
H. oreophilum Klatt. 381.
H. retortoides N. E. Br. 349, 353, 354.
H. rugulosum Less. 436.
H. scapiforme Moeser. 340.
H. scopulosum M. D. Henderson. 2010.
H. setosum Harv. 1221.
H. splendidum (Thunb.) Less. 955, 2011.
H. squamosum Thunb. 635.
H. subglomeratum Less. 613.
H. sutherlandii Harv. 2127, 2149.
H. tenax M. D. Henderson. 2115.
H. trilineatum DC. 358, 617.
H. trilineatum DC. var. *tomentosum* Harv. 359, 361.
H. umbraculigerum Less. 2154, 3070.
Stoebe vulgaris Levyns. 1402.
Metalasia muricata Less. 2119.
Nestlera virgata N. E. Br. 2122.
Macowania corymbosa M. D. Henderson. 847, 2135.
Athrixia phylicoides DC. 846, 1480.
A. pinifolia N. E. Br. 2148
Printzia pyrifolia Less 845, 1477.
Anisopappus smutsii Hutch. 1485.
Acanthospermum hispidum 1682. Introduced.
(*Zinnia pauciflora* L.) *Z. peruviana* (L.) L. Introduced.
Wedelia natalensis Jacq. 1586.
Bidens pilosa L. Introduced.
Tagetes minuta L. 2794. Introduced.
Athanasia acerosa Harv. 2245, 2249.
A. montana Wood & Evans. 2008.
Cenia hispida Harv. 650.
Schistostephium rotundifolium Fenzl. 1461.
Artemisia afra Jacq. 2018.
Gymnopentzia pilifera N. E. Br. 2015, 2153.
Lopholaena platyphylla Benth. 1482.
Senecio albanensis DC. 430.
S. brachypodus DC. 799.
S. burchellii DC. 2022.
S. erubescens Ait. 310 (forma).
S. fulgens Nichols. 2768.
S. glaberximus DC. 1081.
S. inornatus DC. 528.
S. latifolius DC. 2212.
S. macrocephalus DC. 2170.
S. macroglossus DC. 522?, 1064, 2096.
S. pauciligulatus R. A. Dyer & C. A. Smith. 1189.
S. pleistocephalus S. Moore. 1602, 2765.
S. quinquelobus DC. 2767.
S. tamoides DC. 1382.
S. tugelensis Wood & Evans. 616.
S. viminalis Bremek. 1711.
(*Euryops floribundus* N. E. Br.). *E. brevipapposus* M. D. Henderson. 815.
E. evansii Schltr. 844.
E. montanus Schltr. 1135, 2143, 2296.
E. tysonii Phillips. 1992, 2146.
Chrysanthemoides monilifera (L.) T. Norl. (*Osteospermum monilifera* L.) 1716, 2151.
Osteospermum juncundum (Phillips) T. Norl. 2287.
Arctotheca nivea (L.f.) Lewin. 1732.
Gazania rigens (L.) Gaertn. var. *uniflora* (L.f.) Roessler. 1731.

Hirpicium armerioides (DC.) Roessler. 1185.
Berkheya erysithales (DC.) Roessler. 3062.
B. macrocephala J. M. Wood. 305.
B. m'kenii (Harv.) Roessler. 1200.
B. onopordifolia (DC.) O. Hoffm. ex Burtt Davy var. *glabra* Bohnen ex Roessler. 1228.
B. setifera DC. 447.
B. subulata Harv. var. *subulata* 2200.
B. sp. cf. *B. carlinopsis* Welw. ex O. Hoffm. 2803.
Dicoma argyrophylla Oliv. 2802.
D. gerrardii Harv. 2766.
D. speciosa DC. 1496.

GLOSSARY

ASSOCIATION. A climax community with two or more dominants.

ASSOCIES. A community serally equivalent to the association.

BUNCH GRASS. A grass which forms a tuft or bunch.

BUSH CLUMP. A small dense community composed of an aggregation of climbers, shrubs and small trees around one or a few large trees. (cf. Thicket).

CAULIFLOROUS. The production of flowers directly from the trunk or chief branches of a woody plant.

CAULINE. Arising from a stem.

CHAMAEPHYTE. Plants whose perennating buds are located between the surface of the ground and a height of 10 inches (25 cm.).

CLIMATIC CLIMAX. A climax stabilized by climate.

CLIMAX. The end community of a plant succession (sere), the highest type of community that can develop under the sanction of the prevailing natural conditions.

CONSOCIATION. A climax community with a single dominant.

CONSOCIES. A community serally equivalent to the consociation.

CRYPTOGAM. Non-flowering plants, either algae, fungi, lichens, mosses, liverworts, or ferns, reproducing by spores.

DOMINANT. The chief species.

EDAPHIC. Referring to the soil.

ECOLOGY. The study of the mutual relationships of organisms and environment.

ECOSYSTEM. The total system of environment and organisms.

ECOTONE. A transitional vegetation between two communities.

ECOTYPE. A physiological and/or morphological unit or race within a species, adapted to a certain combination of environmental conditions.

ENDEMIC. Indigenous or native in a restricted locality; confined naturally to a limited area or region.

EPIPHYTE. A plant growing upon or attached to another plant, but deriving no sustenance from the supporting plant.

FACIATION. A part of an association which lacks some of the dominants of the association because of slight differences in environmental conditions.

FERRALITIC SOILS. Highly leached, weathered and strongly acid soils, with a low fertility but favourable physical properties.

FERRUGINOUS HARDPAN SOILS. Soils which contain an indurated layer of iron-manganese concretions ("ouklip"), often directly underneath the topsoil.

FERSIALLITIC SOILS. Acid to slightly acid soils from which a large part of the adsorbed bases (metal cations) have been leached, but a considerable proportion of the adsorption complex is saturated and a certain amount of weatherable minerals is still present.

FIELD LAYER. The predominantly herbaceous stratum (including grasses) in a forest or tree community.

FLORISTIC COMPOSITION. The plant species, in the aggregate, that occur in a community or in an area.

FORB. A herb that is not a grass.

FOREST. A community dominated by trees with their crowns interlocking and with at least two or three well developed strata of trees and/or shrubs.

FOREST INITIAL. The first truly forest species appearing in a plant succession, usually following the Forest Precursors (q.v.).

FOREST PRECURSOR. Plants or communities of the stages in the plant succession immediately preceding the formation of forest (cf. Forest Initial).

GEOPHYTE. Plants with underground perennating organs thus able to survive unfavourable conditions, for example, plants with bulbs, tubers or rhizomes.

GROUND LAYER. The layer below the field layer, composed chiefly of small herbs, mosses and lichens.

HELIOPHILOUS. Plants growing best in full sunlight.

HEMICRYPTOPHYTE. Plants whose perennating buds, surviving unfavourable conditions, are located at the soil surface.

HYDROSERE. A plant succession beginning in water.

HYGROPHILOUS, HYGROPHYTE. Used with reference to plants that grow in moist or damp places.

HYTHERGRAPH. A graphical representation of mean monthly temperature and rainfall.

INSOLATION. Radiation received from the sun.

LATERITE. Indurated layer of iron-manganese concretions.

LEACHED SOILS. Soils in which soluble nutrients have been removed by percolating water.

MEDIAN. The central value in a set of numbers arranged from lowest to highest. Thus half the numbers occur above the median, and half below the median (cf. Quartiles).

MESIC. Refers to habitat conditions that are medium in moisture supply, that is, neither excessively dry nor wet.

MESOCLINE. A moist, cool slope; a mesic slope.

MESOPHYTE, MESOPHYTIC. Refers to plants growing in environmental conditions that are medium in moisture conditions.

MONOCLIMAX. The concept of a single climax community to all plant successions within a climatic region.

OROGRAPHIC MIST. Mist or fog produced as a result of the cooling of moisture laden air as it is forced to rise over hills or mountains.

PAN. An undrained depression containing water accumulated as a result of surface flow.

PHENOLOGY. The study of the periodic phenomena of plants and animals and their relations to weather and climate, for example, the time of flowering in plants.

PHYSIOGRAPHY. The science that deals with the physical features of the earth.

PHYTOGEOGRAPHY—(PLANT GEOGRAPHY). The science that deals with the geographic distribution of plants and the causes of their distribution and dispersal.

PHYTOSOCIOLOGY, PLANT SOCIOLOGY. The study of plant communities, including their origin, composition, structure, characteristics, distribution, dynamics and classification.

PIONEER PLANTS (STAGES). The earliest plants (stages) in a plant succession on a bare area.

PLANT COMMUNITY. A general term for any aggregation of plants having mutual relationships among themselves and to their environment.

POLYCLIMAX. The concept that there may be several climaxes to plant successions, that is, climaxes may be due to climate, physiography, soils, fire or men.

POSTCLIMAX. A community developing under more mesic conditions than those producing the climatic climax.

PRECLIMAX. A community stabilized by conditions more xeric than those producing the climatic climax.

PRIMARY. Not due to the activities of man or his domestic animals.

PRIMARY SUCCESSION. Succession beginning on a bare area not previously occupied by plants.

QUARTILE. The value, in a set of numbers arranged from lowest to highest, below which are 25% of the numbers in the case of the Lower Quartile, and above which are 25% of the numbers in the case of the Upper Quartile (cf. Median).

REEDSWAMP. A community of tall grasses (e.g. reeds), sedges or bulrush growing in shallow water or on wet soil where the water table is near the surface.

RELIC. A community or species remnant of a former vegetation.

SAVANNA. A community dominated by trees, separated usually by more than twice their crown diameter, and with a heliophilous grass stratum between the trees.

SCIOPHYTIC. Plants growing best in shade.

SCRUB. A dense community dominated by small trees and shrubs, mainly less than twelve feet high, penetrated with some difficulty.

SCRUB-FOREST. Intermediate between scrub and forest, and composed of spaced to dense growths of trees over 15 ft. high, with dense strata of small trees and shrubs.

SECONDARY. Due to the activities of man or his domestic animals.

SERE, SERAL. Refers to a unit of succession from initial to climax stages.

SOLODISED SOLONETZIC SOILS. Partly leached soils with slightly acid to acid topsoils resting upon neutral to alkaline, firm, impenetrable clay subsoils, usually containing lime nodules at depth.

STOLON, STOLONIFEROUS. Refers to a horizontal stem on the surface of the ground where it propagates vegetatively by forming new shoots and roots at the nodes.

SUBCLIMAX. A subfinal stage in the succession, stabilized by natural or artificial factors other than climate.

SUCCESSION. The replacement of one community by another as a result of natural and progressive (rarely regressive) development.

THICKET. A dense community, penetrated with difficulty, with a single dominant (cf. Bush Clump).

TREE VELD. See Savanna.

UNLEACHED ARID SOILS. Mildly to strongly alkaline soils whose colloidal complex is highly, often fully saturated with bases (metal cations). Free lime, in the form of powder, nodular, or even as a lime pan, present in subsoils and often in topsoil.

VALLEY MIST. Mist or fog produced as a result of the drainage of cold air into valleys and depressions.

VERTISOLS. Neutral to alkaline black, clay soils, showing a low degree of leaching and weathering, developed mainly from dolerite materials ("Black Turfs").

VLEI. A moist or marshy area with permanent or temporary standing water.

WOODLAND. A community of trees with their crowns interlocking or spaced less than twice their crown diameter apart. Lower tree and shrub strata may be absent or poorly represented.

XERIC. Refers to dry habitat conditions.

XEROCLINE. A dry, warm slope.

XEROMORPHIC. The structure or form characteristic of organs of plants adapted to dry habitats.

XEROPHYTE, XEROPHYTIC. Refers to plants that can grow in dry places.

XEROSERE. A series of successional stages beginning in dry habitats.

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